DIVISION 9 MATERIALS

SECTION 9-00 DEFINITIONS AND TESTS

9-00.1 FRACTURE

Fractured aggregate is defined as aggregate particles which have one or more fractured faces. A face will be counted as fractured whenever one-half or more of the projected area of the particle is comprised of a fractured face when viewed normal to the fractured face.

9-00.2 WOOD WASTE

Wood waste is defined as all material which, after drying to constant weight, has a specific gravity of less than 1.0.

9-00.3 TEST FOR WEIGHT OF GALVANIZING

At the option of the Engineer, the weight of zinc in ounce per square foot required by the various galvanizing Specifications may be determined by an approved magnetic thickness gage calibrated within last 6 months for accuracy and demonstrated to the approval of the Engineer, in lieu of the other methods specified.

9-00.4 SIEVE ANALYSIS OF AGGREGATES

Sieve analysis for acceptance of aggregate gradation will comply with procedures described in Section 9-03.15.

9-00.5 DUST RATIO

The dust ratio is defined as the percent of material passing the U.S. No. 200 sieve divided by the percent of material passing the U.S. No. 40 sieve.

9-00.6 SAND/SILT RATIO

The sand/silt ratio is defined as the percent of material passing the U.S. No. 10 sieve divided by the percent of material passing the U.S. No. 200 sieve.

9-00.7 GALVANIZED HARDWARE, AASHTO M 232

An acceptable alternate to hot-dip galvanizing in accordance with AASHTO M 232 will be zinc coatings mechanically deposited in accordance with AASHTO M 298, providing the minimum thickness of zinc coating is not less than that specified in AASHTO M 232, and the process does not produce hydrogen embrittlement in the base metal. Sampling and testing will be made by the Engineer in accordance with commonly recognized national standards and methods used in the SPU Materials Laboratory.

SECTION 9-01 PORTLAND CEMENT AND BLENDED HYDRAULIC CEMENT

9-01.1 TYPES OF CEMENT

Cement shall be classified as portland cement or blended hydraulic cement.

9-01.2 SPECIFICATIONS

9-01.2(1) PORTLAND CEMENT

Portland cement shall meet the requirements of AASHTO M 85 or ASTM C 150 Types I, II, or III portland cement, except that the cement shall not contain more than 0.75-percent alkalis by weight calculated as Na20 plus 0.658 K20 and the content of Tricalcium aluminate (C_3A) shall not exceed 8-percent by weight calculated as 2.650A1203 minus 1.692Fe203. Processing additions shall meet the requirements of ASTM C 465 and the total amount of processing additions used shall not exceed 1-percent of the weight of Portland cement clinker. Cement kiln dust may be used as a process addition above 1-percent but not exceed 4-percent of the weight of Portland cement clinker. When process additions greater than 1-percent are used, the type and amount of processing additions used shall be shown on mill test reports.

The time of setting shall be determined by the Vicat Test method per AASHTO T 131 or ASTM C 191.

9-01.2(2) RESERVED

9-01.2(3) LOW ALKALI CEMENT

When it is required by the Engineer that low alkali cement shall be used, the percentage of alkalis in the cement shall not exceed 0.60 percent by weight calculated as Na_20 plus 0.658 K_20. This limitation shall apply to all types of Portland cement.

9-01.2(4) BLENDED HYDRAULIC CEMENT

Blended hydraulic cement shall be either Type IP or Type IS cement conforming to AASHTO M 240 or ASTM C-595, except that the blended hydraulic cement shall not contain more than 0.75-percent alkalis by weight calculated as Na_20 plus 0.658 K_20 and the content of Tricalcium aluminate (C_3A) shall not exceed 8-percent by weight calculated as $2.650A1_20_3$ minus $1.692Fe_20_3$ and meet the following additional requirements:

1. Type IP(X), Portland Pozzolan Cement, where (X) dictates pozzolan percentage. Type IP, (X) Portland Pozzolan Cement, shall be Portland Cement and Pozzolan and the pozzolan shall be limited to fly ash or ground granulated blast furnace slag. Fly ash is limited to a maximum of 35-percent by weight of the cementitious material. Ground granulated blast furnace slag is limited to a maximum of 40-percent by weight of the cementitious material.

2. Type IS(X), Portland Blast Furnace Slag Cement, where (X) dictates slag percentage. Type IS(X), Portland Slag Cement, shall be Portland cement and ground granulated blast furnace slag. The addition of ground granulated blast furnace slag shall be limited to a maximum of 40-percent by weight of the cementitious material.

The source and weight of the fly ash or ground granulated blast furnace slag shall be certified on the cement mill test certificate and shall be reported as a percent by weight of the total cementitious material. The fly ash or ground granulated blast furnace slag constituent content in the finished cement will not vary more than plus or minus 5 percent by weight of the finished cement from the certified value.

Fly ash shall meet the requirements of Section 9-23.9 of these Standard Specifications.

Ground granulated blast furnace slag shall meet the requirements of Section 9-23.10 of these Standard Specifications.

9-01.3 RESERVED

9-01.4 RESERVED

9-01.5 RESERVED

SECTION 9-02 BITUMINOUS MATERIALS

9-02.1 ASPHALT MATERIAL

9-02.1(1) GENERAL

Asphalt furnished under these Specifications shall not have been distilled at a temperature high enough to injure by burning or to produce flecks of carbonaceous matter, and upon arrival at the Work, shall show no signs of separation into lighter and heavier components.

9-02.1(2) MEDIUM-CURING (MC) LIQUID ASPHALT

CHARACTERISTICS		AASHTO TEST METHOD	MC-70	MC-250	MC-800	MC-3000
Kinematic Viscosity at 140°F (cSt)		T 201	70-140	250-500	800-1600	3000-6000
Flash Point (Tag Open Cup)	Min. °F	T 79	100	150	150	150
Water Content	Min. %	T 55	0.2	0.2	0.2	0.2
Distillation: volume % of total distillate		T 78				
to 680 °F			0-20	0-10	---	---
to 437 °F			20-60	15-55	0-35	0-15
to 500 °F			65-90	60-87	45-80	15-75
to 600 °F			55	67	75	80
Residue of 680°F distillation % volume by difference	Min.					
Properties of residue from distillation to 680 °F Absolute viscosity at 140°F (poise)		T 202	300-1200	300-1200	300-1200	300-1200
[1]Ductility, 5 cm/min. at 77°F	Min.	T 51	100	100	100	100
Solubility in trichloroethylene	Min. %	T 44	99.0	99.0	99.0	99.0

Note 1. If the ductility at 77°F is less than 100, the Material will be acceptable if its ductility at 60°F is more than 100.

The Material shall not foam when heated to the application temperature recommended in 2010 edition WSDOT standard specification section 5-02.3(3).

9-02.1(3) RAPID-CURING (RC) LIQUID ASPHALT

CHARACTERISTICS		AASHTO TEST METHOD	RC-70	RC-250	RC-800	RC-3000
Kinematic Viscosity at 140°F cSt		T 201	70-140	250-500	800-1600	3000-6000
Flash Point (Tag Open Cup)	Min. °F	T 79	---	80	80	80
Water Content	Min. %	T 55	0.2	0.2	0.2	0.2
Distillation: volume % of total distillate to 680°F		T 78				
to 374°F	Min.		10	---	---	---
to 437°F	Min.		50	35	15	---
to 500°F	Min.		70	60	45	25
to 600°F	Min.		85	80	75	70
Residue of 680°F distillation % volume by difference	Min.		55	65	75	80

Properties of residue from distillation to 680°F						
Absolute viscosity at 140°F	poise	T 202	600-2400	600-2400	600-2400	600-2400
Ductility, 5 cm/min. at 77°F, cm	Min.	T 51	100	100	100	100
Solubility in trichloroethylene	Min. %	T 44	99.0	99.0	99.0	99.0

The Material shall not foam when heated to application temperature recommended in 2010 edition WSDOT standard specification section 5-02.3(3).

9-02.1(4) ASPHALT CEMENT

9-02.1(4)A PAVING ASPHALT

Asphalt cement binder shall meet the requirements of AASHTO M 320 and shall be of the grade specified in the Contract.

9-02.1(4)B PERFORMANCE GRADE (PG) ASPHALT CEMENT

BINDER GRADE	**PG 58-**			**PG 64-**			**PG 70-**			**PG 76-**	
	-22	-28	-34	-22	-28	-34	-22	-28	-34	-22	-28
ORIGINAL BINDER											
Flash Point Temp., AASHTO T 48	230 °C MIN.										
Rotational Viscosity, AASHTO T 316	3 Pa s Max. @ 135 °C										
Dynamic Shear, AASHTO T 315	G*/Sin δ = 1.00 kPa Min.; Frequency = 10 rad/s										
	Test Temp. (°C)										
	58 °C			64 °C			70 °C			6 °C [7]	
ROLLING THIN FILM OVEN RESIDUE, AASHTO T 240											
Mass Loss, AASHTO T 240	1.00 Percent Max.										
Dynamic Shear, AASHTO T 315	G*/Sin δ = 2.20 kPa Min.; Frequency = 10 rad/s										
	Test Temp. (°C)										
	58			64			70			6 [7]	
PRESSURE AGING VESSEL RESIDUE, AASHTO R 28											
PAV Aging Temp., AASHTO R 28	100 °C										
Dynamic Shear, AASHTO T 315	G*/Sin δ = 5,000 kPa Max.; Frequency = 10 rad/s										
	Test Temp. (°C)										
	22	19	16	25	22	19	28	25	22	31	28
Creep Stiffness, AASHTO T 313	S= 300 Mpa Max.; m-value= 0.300 Min.										
	Test Temp. @ 60s (°C)										
	-12	-18	-24	-12	-18	-24	-12	-18	-14	-12	-18

Note: All Performance Grade binders not included in this chart shall meet the requirements of Table 1 contained in AASHTO M 320, “Performance-Graded Asphalt Binder”.

9-02.1(5) REJUVENATING (RECYCLING) AGENTS

The rejuvenating agent shall be a liquid emulsion of selected resin petroleum oil approved for use by the SPU Materials Laboratory. Rejuvenating agents shall meet the following Specifications for the grade designated:

HOT MIX RECYCLING AGENTS[1]

		RA 5		RA 25		RA 75		RA 250		RA 500	
TEST	**ASTM TEST METHOD**	**MIN.**	**MAX.**	**MIN.**	**MAX.**	**MIN.**	**MAX.**	**MIN.**	**MAX.**	**MIN.**	**MAX.**
Original Test											
Viscosity @ 140°F. cSt	D 2170 or D 2171	200	800	1000	4000	5000	10,000	15,000	35,000	40,000	60,000
Flashpoint, COC, °F	D 92	400	---	425	---	450	---	450	---	450	---
Saturates, Wt. %	D 2007	---	30	---	30	---	30	---	30	---	30
Specific Gravity	D 70 or D 1298	Report		Report		Report		Report		Report	
Residue test from RTFC	D 2872[2]										
Viscosity Ratio[3]		---	3	---	3	---	3	---	3	---	3
Weight Change ± %		---	4	---	3	---	2	---	2	---	2

[1]The final acceptance of recycling agents meeting this Specification is subject to the compliance of the reconstituted asphalt blends with the requirements in Section 9-02 for the class of asphalt mix required.

[2]The use of ASTM D 1754 has not been studied in the context of this Specification; however, it may be applicable. In cases of dispute, the reference method shall be ASTM D 2872.

[3]Viscosity Ratio = $\frac{\text{RTFC Viscosity at 140°F, cSt}}{\text{Original Viscosity at 140°F, cSt}}$

9-02.1(6) CATIONIC EMULSIFIED ASPHALTS

See the following Cationic Emulsified Asphalt Table.

CATIONIC EMULSIFIED ASPHALT																	
	TYPE	**RAPID SETTING**				**MEDIUM SETTING**						**SLOW SETTING**				**SPECIAL TRACK**	
GRADE	**AASHTO TEST METHOD**	**CRS-1**		**CRS-2**		**CMS-2S**		**CMS-2**		**CMS-2H**		**CSS-1**		**CSS-1H**		**STE-1**	
		MIN.	**MAX.**	**MIN.**	**MAX.**	**MIN.**	**MAX.**	**MIN.**	**MAX.**	**MIN.**	**MAX.**	**MIN.**	**MAX.**	**MIN.**	**MAX.**	**MIN.**	**MAX.**
TEST ON EMULSIONS:																	
Viscosity Saybolt Furol S @ 77°F (25°C)	T 59	---	---	---	---	---	---	---	---	---	---	20	100	20	100	---	30
Viscosity Saybolt Furol S @ 122°F (50°C)	T 59	20	100	150	400	50	450	50	450	50	450	---	---	---	---	---	---
Storage stability test 1 day %	T 59	---	1	---	1	---	1	---	1	---	1	---	1	---	1	---	1
Demulsibility 35 m.l. 0.8% sodium dioctyl sulfosuccinate, %[1]	T 59	40	---	40	---	---	---	---	---	---	---	---	---	---	---	25	---
COATING ABILITY & WATER RESISTANCE:																	
Coating, dry aggregate	T 59	---	---	---	---	good	---	good	---	good	---	---	---	---	---	---	---
Coating, after spraying	T 59	---	---	---	---	fair	---	fair	---	fair	---	---	---	---	---	---	---
Coating, wet aggregate	T 59	---	---	---	---	fair	---	fair	---	fair	---	---	---	---	---	---	---
Coating, after spraying	T 59	---	---	---	---	fair	---	fair	---	fair	---	---	---	---	---	---	---
Particle charge test	T 59	positive		Positive		positive		positive		positive		positive[2]		positive[2]		Positive	
Sieve Test, %	T 59	---	0.10	---	0.10	---	0.10	---	0.10	---	0.10	---	0.10	---	0.10	---	0.10
Cement mixing test, %	T 59	---	---	---	---	---	---	---	---	---	---	---	2.0	---	2.0	---	---
Distillation:																	
Oil distillate by vol. Of emulsions %	T 59	---	3	1.5	3	---	20	---	12	---	12	---	---	---	---	---	5
Residue, %	T 59	60	---	65	---	60	---	65	---	65	---	57	---	57	---	45	---
TESTS ON RESIDUE FROM DISTILLATION TEST:																	
Penetration, 77°F (25°C)	T 49	100	250	100	250	100	250	100	250	40	90	100	250	40	90	100	200
Ductility, 77°F (25°C) 5 cm/min., cm	T 51	40	---	40	---	40	---	40	---	40	---	40	---	40	---	40	---
Solubility in trichlorethylene, %	T 44	97.5	---	97.5	---	97.5	---	97.5	---	97.5	---	97.5	---	97.5	---	97.5	---

Notes: 1. The demulsibility test shall be made within 30 days from date of shipment.
2. If the particle charge test for CSS-1 and CSS-1h is inconclusive, material having a maximum pH value of 6.7 will be acceptable.

9-02.1(6)A POLYMERIZED CATIONIC EMULSIFIED ASPHALT – CRS-2P

The asphalt CRS-2P shall be a polymerized cationic emulsified asphalt. The polymer shall be milled into the asphalt or emulsion during the manufacturing of the emulsion. The asphalt CRS-2P shall meet the following Specifications:

		AASHTO TEST METHOD	SPECIFICATIONS	
			MINIMUM	MAXIMUM
Viscosity @122ºF, SFS		T 59	200	400
Storage Stability 1 day %		T 59	---	Note 1
Demulsibility 35 ml. 0.8% Dioctyl Sodium Sulfosuccinate		T 59	40	---
Particle Charge		T 59	Positive	---
Sieve Test %		T 59	---	0.30
Distillation				
	Oil distillate by vol. of emulsion %	T 59 (Note 1)	0	Note 3
	Residue	T 59	65	---
Test on the Residue From Distillation				
	Penetration @77ºF	T 49	100	250
	Torsional Recovery % Or Toughness/Tenacity in-lbs	Note 2 Note 3	18 50/25	--- ---

NOTES:
1. Distillation modified to use 300 grams of emulsion heated to 350 ºF ± 9 Fº and maintained for 20 minutes.
2. The Torsional Recovery test shall be conducted according to the California Department of Transportation Test Method No. 332.
3. Benson method of toughness and tenacity; Scott tester, inch-pounds at 77 ºF, 20 in. per minute pull. Tension head $^{7}/_{8}$ in. diameter.

At the option of the Supplier, the Benson Toughness/Tenacity test can be used in lieu of Torsional Recovery based on type of modifier used. If the Benson Toughness/Tenacity method is used for acceptance, the Supplier shall supply all test data verifying Specification conformance as part of the Manufacturer's Certificate of Compliance.

9-02.1(7) ASPHALT FOR SUB-SEALING

Asphalt for sub-sealing shall conform to the requirements of AASHTO M 238 except that the minimum softening point shall be 170°F.

9-02.1(8) HOT MELT TRAFFIC BUTTON ADHESIVE

The bitumen adhesive Material shall conform to the following requirements:

SPECIFICATION	ASTM TEST METHOD	REQUIREMENT
Flash Point, COC °F	D 92	550 Min.
Softening Point, °F	D 36	200 Min.
Brookfield Viscosity, 400°F	D 2196	7,500 cP, Max.
Penetration, 100g, 5 sec, 77°F	D 5	10 – 20 dmm
Filler Content, % by weight (Insoluble in 1,1,1 Trichloroethane)	D 2371	50 – 75

Filler Material shall be calcium carbonate and shall conform to the following fineness:

SIEVE SIZE	PERCENT PASSING
No. 100	100
No. 200	95
No. 325	75

Hot melt bitumen adhesive shall develop bond pull-off strength greater than 100 psi between 0°F and 120°F.

9-02.1(9) RESERVED

9-02.2 SAMPLING AND ACCEPTANCE

9-02.2(1) CERTIFICATION OF SHIPMENT

Bituminous materials may be accepted by the Engineer based on the asphalt Supplier's Manufacturer's Certificate of Compliance incorporated in their Bill of Lading. This certification shall include a statement certifying Specification compliance

for each delivery of product shipped. Failure to provide this certification with the shipment shall be cause for rejection of the Material. The following information is required on this Bill of Lading:

1. Date shipped.
2. Project Name and PW No.
3. Grade of Commodity and Manufacturer's Certificate of Compliance.
4. Anti-stripping additive brand, grade, and percentage.
5. Mass (Net Tons).
6. Volume (Gross Gallons).
7. Temperature of Load (°F).
8. Bill of Lading Number.
9. Consignee and Delivery Point.
10. Signature of Supplier's Representative.
11. Supplier (Bill of Lading Generator Business Name).
12. Supplier's Address.

The Bill of Lading shall be supplied at the time of shipment of each load delivered. In addition to the copies the Contractor requires, one copy of the Bill of Lading including the Manufacturer's Certificate of Compliance shall be sent with the shipment for the sole use of Engineer.

9-02.2(2) SAMPLES

When requested by the Engineer, the asphalt Supplier shall submit, by prepaid express or US mail, samples of asphalt binder that represent current production to the SPU Materials Laboratory in accordance with Section 1-05.3(1)C at no cost to the Owner. At the discretion of the Engineer, samples of asphalt binder may be obtained by the Engineer from the Contractor's storage tanks.

9-02.3 TEMPERATURE OF ASPHALT

The temperature of paving asphalts in storage tanks when loaded for transporting shall not exceed the maximum temperature recommended by the asphalt binder manufacturer.

9-02.4 ANTI-STRIPPING ADDITIVE

When the Engineer requires heat-stable anti-stripping additive be added to the asphalt mix, then at the option of the Contractor, the method of adding anti-stripping additive can either be by direct mixing with the liquid asphalt, or by spraying on the aggregate on the cold feed. Once the method and type of anti-stripping additive proposed by the Contractor have been approved by the Engineer, the method, brand, grade, and amount of anti-stripping additive shall not be changed without approval of the Engineer.

The amount of liquid anti-stripping additive designated by the Engineer to be used shall not exceed 1 percent by weight of the liquid asphalt.

When polymer additives are sprayed on the aggregate, the amount will be designated by the Engineer, but shall not exceed 0.67 percent by weight of the aggregate.

The use of another process or procedure for adding anti-stripping additive to the asphalt mix will be considered based on a proposal from the Contractor.

9-02.5 TEMPORARY PAVEMENT PATCH MATERIAL

Four (4) temporary pavement patch Material products approved by the Engineer for use include:

1. Unique Paving Material (UPM)
   Alpine Products
   Phone: (253) 351-9828
   E-mail: Skip@alpinetrafficproducts.com
   Web-site: www.upm.com

2. Quality Pavement Repair (QPR)
   Phone: 1-800-388-4338
   Web-site: www.qprcoldpatch.com

3. E Z Street
   Lakeside Industries
   PO Box 7016
   Issaquah, WA 98027
   Phone: (425) 313-2681
   E-Mail: rickr@lakesideind.com
   Web-site: www.lakesideind.com

4. U.S. Cold Patch.
   Phone: (425) 244-5000
   FAX: (425) 423-9120
   Web-site: www.uscoldpatch.com

Other temporary patching products may be submitted to the Engineer for approval.

SECTION 9-03 AGGREGATES

9-03.0 GENERAL

Mineral Aggregates most commonly used have each been given a Type number to identify a unique Mineral Aggregate blend known as "Mineral Aggregate Type (No.)". See the definition of "Mineral Aggregate" in Section 1-01.3. Requirements for each Mineral Aggregate identified by a Type number are contained in Sections 9-03.1, and 9-03.9 through 9-03.16. Mineral Aggregates shall be composed of clean, uniform (in quality) particulate size groups essentially free from wood waste and other deleterious Materials. They shall be obtained only from sources approved by the Engineer. Written requests for source approval shall be submitted to the Engineer not less than Working 10 Days prior to the intended use of the Mineral Aggregate. Should the proposed source be one that the Engineer has no history of Material performance with, the Engineer reserves the right to take preliminary samples at the proposed source, and make preliminary tests, to first determine acceptability of the new source and then perform the applicable Material approval testing. Continued approval of a source is contingent upon the Mineral Aggregates from that source continuing to meet Contract requirements.

Mineral aggregates shall meet the Standard Specifications for grading and quality for use in the Work; however, allowable exceptions may be specified in Contract. The Engineer shall reserve the right to sample and test Mineral Aggregate at any time including at the source.

Recycled materials to be used as aggregates shall meet the requirements specified in Section 9-3.18(1).

All percentages are by weight unless otherwise specified.

9-03.1 AGGREGATES FOR PORTLAND CEMENT CONCRETE

9-03.1(1) GENERAL REQUIREMENTS

Portland cement concrete aggregates shall be manufactured from ledge rock, talus, or sand and gravel in accordance with the provisions of Section 3-01. They shall possess the characteristics of shape and size such that the concrete, resulting from a mixture of fine and coarse aggregates in the specified proportions, has workability acceptable to the Engineer. Regardless of compliance with all other provisions of these Specifications, if the concrete is not of a workable character, or does not exhibit a proper surface when finished, either the fine or the coarse aggregate or both, will be rejected, or shall be altered as required by the Engineer.

Prior to approval of any portland cement concrete mix design, results of tests performed in accordance with ASTM C 1293 at an age of 12 months for the proposed coarse and fine aggregates shall be submitted to the Engineer for evaluation of the potential for alkali silica reaction (ASR). The test shall be conducted by a laboratory accredited for the test and the test results shall be no older than 24 months from the date of the submittal. If results of ASTM C 1293 testing are not available, the Engineer may accept results of ASTM C 295 for evaluation in the interim until results of ASTM C 1293 tests are available and submitted for evaluation. In no case shall the interim between the submittal of ASTM C 295 results and the submittal of ASTM C 1293 results exceed 14 months. In the event that the time period between ASTM C 295 evaluation submittal and ASTM C 1293 test results submittal exceeds 14 months, aggregate sources that have been approved for use in mix designs based on the results of ASTM C 295 evaluation shall be rejected, and mix design approvals incorporating those aggregates from those sources shall be rescinded,

It is the intent of this specification that aggregate sources have current ASTM C 1293 test results on file and that those results shall be updated every 24 months at a maximum. The interim ASTM C 295 testing is intended to provide a mechanism to evaluate new aggregate sources until ASTM C 1293 test results can be submitted and not as a means to gain final approval. The 14 month time period between the submittal of ASTM C 295 test results and ASTM C 1293 test results shall not be limited to a single contract and shall begin upon the first submittal of ASTM C 295 test results regardless of project or contract.

If, in the judgment of the Engineer, based on previous experience or on Laboratory tests, concrete aggregates from a given source are detrimentally reactive with alkalies in Portland cement, that source shall not be used. Upon determination of detrimentally reactive aggregates, the Contractor may submit results of testing by ASTM 1567 for each proposed mix design incorporating ASR mitigation measures for evaluation by the Engineer. If the Engineer determines that the Contractor's ASR mitigation is effective for a mix design, the Engineer may approve the mix design for use. Determination of the effectiveness of the proposed mitigation measures for a mix design shall lie with the Engineer.

9-03.1(2) FINE AGGREGATE FOR PORTLAND CEMENT CONCRETE

9-03.1(2)A GENERAL

Fine aggregate for Portland cement concrete shall consist of sand or other inert Materials, or combinations thereof, approved by the Engineer, having hard, strong, durable particles free from adherent coating. Fine aggregate shall be washed thoroughly to remove clay, loam, alkali, organic matter, or other deleterious matter.

9-03.1(2)B DELETERIOUS SUBSTANCES

The amount of deleterious substances in the washed aggregate shall not exceed the following values:

- Particles having a specific gravity less than 1.95 shall not exceed 1.0 percent of total weight.
- Organic matter, by calorimetric test, shall not be darker than the reference standard color (organic plate No. 3) AASHTO T 21 unless other tests prove a darker color to be harmless.

9-03.1(2)C GRADING

Fine aggregate for Portland cement concrete shall be graded to conform to the following requirements expressed as percentages by weight:

SIEVE	TYPE 6 CLASS 1		TYPE 7 CLASS 2	
	MAX.	MIN.	MAX.	MIN.
3/8 Square	---	100	---	100
% Passing U.S. No.4	100	95	100	95
% Passing U.S. No.8	86	68	---	---
% Passing U.S. No.16	65	47	80	45
% Passing U.S. No.30	42	27	---	---
% Passing U.S. No.50	20	9	30	10
% Passing U.S. No.100	7	0	10	2
% Passing U.S. No.200 (wet sieving)	2.5	0	2.5	0

For fine aggregate Class 1, individual test variations under the minimum or over the maximum will be permitted as follows, provided the average of three consecutive tests is within the Specification limits:

SIEVE NUMBER	PERMISSIBLE VARIATION IN INDIVIDUAL TESTS
No. 30 and coarser	2.0 percent
No. 50 and finer	0.5 percent

Within the gradation limits for fine aggregate Class 2, uniformity of gradation shall be limited to a range of plus or minus 0.20 of the reference Fineness Modulus. The reference Fineness Modulus shall be determined from a representative sample from the proposed source as submitted by the Contractor.

9-03.1(2)D USE OF SUBSTANDARD GRADINGS

Fine aggregate with more than the maximum percentage passing any sieve may be accepted provided the cement content of the finished concrete is increased, at the Contractor's cost, by 1/3 percent for each 1 percent the fine aggregate passing each sieve is in excess of the maximum.

Under no circumstances shall fine aggregate Class 1 be used which has a grading finer than the following:

SIEVE SIZE	PERCENT PASSING
U.S. No. 8	95
U.S. No. 16	80
U.S. No. 30	60
U.S. No. 50	25
U.S. No. 200	2.5

All percentages are by weight.

9-03.1(2)E USE OF CRUSHED RECYCLED PORTLAND CEMENT CONCRETE

Recycled portland cement concrete shall not be used as fine aggregate for new portland cement concrete.

9-03.1(3) COARSE AGGREGATE FOR PORTLAND CEMENT CONCRETE

9-03.1(3)A GENERAL

Coarse aggregate for Portland cement concrete shall consist of gravel, crushed stone, or other inert Material or combinations thereof approved by the Engineer, having hard, strong, durable pieces free from adherent coatings. Coarse aggregate shall be washed thoroughly to remove clay, silt, bark, sticks, alkali, organic matter, or other deleterious Material.

9-03.1(3)B DELETERIOUS SUBSTANCES

The amount of deleterious substances in the washed aggregate shall not exceed the following values:

Amount finer than U.S. No. 200	0.5 percent by weight
Pieces with a specific gravity less than 1.95	2.0 percent by weight
Clay lumps	0.5 percent by weight
Shale	2.0 percent by weight
Wood Waste	0.05 percent by weight

9-03.1(3)C DURABILITY

Coarse aggregate shall not have a percentage of wear in the Los Angeles machine in excess of 35 after 500 revolutions in accordance with ASTM C 131. Additionally, when tested in accordance with WSDOT Test Method T 113, coarse aggregate shall not have a Degradation Factor less than 30.

9-03.1(3)D GRADING

Coarse aggregate for Portland cement concrete when separated by means of laboratory sieves shall conform to one or more of the following gradings as called for elsewhere in the Specifications, Special Provisions or in the Plans:

	PERCENT PASSING											
	AASHTO GRADING NO. 467		AASHTO GRADING NO. 4		AASHTO GRADING NO. 57		AASHTO GRADING NO. 67		AASHTO GRADING NO. 7		AASHTO GRADING NO. 8	
SIEVE SIZE	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
2” square	100	---	100	---	---	---	---	---	---	---	---	---
1-1/2" square	95	100	90	100	100	---	---	---	---	---	---	---
1" square	---	---	20	55	95	100	100	---	---	---	---	---
3/4" square	35	70	0	15	---	---	90	100	100	---	---	---
1/2" square	---	---	---	---	25	60	---	---	90	100	100	---
3/8" square	10	30	0	5	---	---	20	55	40	70	85	100
U.S. No. 4	0	5	---	---	0	10	0	10	0	15	10	30
U.S. No. 8	---	---	---	---	0	5	0	5	0	5	0	10
U.S. No. 16	---	---	---	---	---	---	---	---	---	---	0	5

All percentages are by weight.

In individual tests, a variation of four percent under the minimum percentages or over the maximum percentages will be allowed. The average of three successive tests shall be within the percentages stated above. Coarse aggregate shall contain no pieces larger than two times the maximum sieve size for the specified grading measured along the line of greatest dimension.

Acceptance of grading and quality of the aggregate will be based on samples taken from stockpiles at the concrete plant. The exact point of acceptance will be determined in the field by the Engineer.

When the Engineer approves, the coarse aggregate may be blended from other sizes if:

1. The resulting aggregate meets all requirements for specified grading;
2. Each size used makes up at least 5 percent of the blend;
3. The Contractor supplies the Engineer with gradings for the proposed sizes, along with their proper proportions. If the aggregate comes from commercial sources, the Contractor shall supply this information and have it approved before proportioning and mixing the concrete.

9-03.1(3)E USE OF CRUSHED RECYCLED PORTLAND CEMENT CONCRETE

With the approval of the Engineer, crushed recycled portland cement concrete may be used as coarse aggregate for classes of concrete with a specified compressive strength of 2,500 psi or less. Crushed recycled portland cement concrete shall meet all of the requirements for coarse aggregate contained in Section 9-03.1(3). Recycled concrete that exhibits effects of alkali silica reaction, carbonate silica reaction, sulfate reaction or any other deleterious condition, shall not be used. The concrete producer shall submit a certification that the crushed recycled concrete was produced from sound stock and is not affected by these or any other deleterious conditions.

In addition to the requirements of Section 9-03.1(3)B, crushed recycled portland cement concrete shall contain an aggregated weight of less than 1 percent of asphalt concrete, brick, porcelain or other deleterious substance(s) not otherwise noted.

Crushed recycled portland cement concrete aggregate shall be in a saturated condition prior to mixing and the water cement ratio of the final mix shall be limited to 0.45 maximum. Should the hardened concrete exhibit excessive cracking, unacceptable compressive strength or other undesirable characteristics, use of the mix shall be discontinued.

9-03.1(4) COMBINED AGGREGATE GRADATION FOR PORTLAND CEMENT CONCRETE

As an option to using Coarse and Fine graded aggregates for Portland Cement Concrete, aggregate gradation may consist of a combined gradation. Aggregates shall consist of sand, gravel, crushed stone, or other inert material or combinations thereof, having hard, strong durable particles free from adherent coatings. Aggregates shall be washed to remove clay, loam, alkali, organic matter, silt, bark, sticks, or other deleterious matter.

9-03.1(4)A DELETERIOUS SUBSTANCES

The amount of deleterious substances in the washed aggregate shall not exceed the following values:

Particles of specific gravity less than 1.95	2.0 percent by weight
Organic matter, by colorimetric test, shall not be darker than the reference Standard color (organic plate No. 3) AASHTO T21 unless other tests prove a darker color to be harmless.	
Percentage of wear in Los Angeles machine for aggregates retained on the No. 4 sieve after 500 revolutions.	35 maximum
Clay Lumps	0.3 percent by weight
Shale	1.00 percent by weight
Wood Waste	0.03 percent by weight
Amount finer than No. 200 Sieve	2.0 percent by weight

9-03.1(4)B GRADING

If a nominal maximum aggregate size is not specified, the Contractor shall determine the nominal maximum aggregate size, using ACI 211.1 as a guide. In no case will the maximum aggregate size exceed one-fifth of the narrowest dimension between sides of the forms, one-third the depth of slabs, nor three-fourths of the minimum clear spacing between individual reinforcing bars, bundles of bars, or pretensioning strands.

The combined aggregate shall conform to the following requirements based upon the nominal maximum aggregate size.

NOMINAL MAXIMUM AGGREGATE SIZE	3	2-1/2	2	1-1/2	1	3/4	1/2	3/8	No. 4
3-1/2”	100								
3”	93-100*	100							
2-1/2”		92-100*	100						
2”	76-90		90-100*	100					
1-1/2”	66-79	71-88		87-100*	100				
1”	54-66	58-73	64-83		82-100*	100			
¾”	47-58	51-64	55-73	62-88		87-100*	100		
½”	38-48	41-54	45-61		57-83		81-100*	100	
3/8”	33-43	35-47	39-54	43-64		60-88		86-100*	100
No. 4	22-31	24-34	26-39	29-47	34-54	41-64	48-73		68-100*
No. 8	15-23	16-25	17-29	19-34	22-39	27-47	31-54	39-73	
No. 16	9-17	10-18	11-21	12-25	14-29	17-34	20-39	24-54	28-73
No. 30	5-12	6-14	6-15	7-18	8-21	9-25	11-29	13-39	16-54
No. 50	2-9	2-10	3-11	3-14	3-15	4-18	5-21	6-29	7-39
No. 100	0-7	0-7	0-8	0-10	0-11	0-14	0-15	0-21	0-29
No. 200	0-2.0	0-2.0	0-2.0	0-2.0	0-2.0	0-2.0	0-2.0	0-2.0	0-2.5
* Nominal Maximum Size									

All percentages are by weight.

Nominal maximum size for concrete aggregate is defined as the smallest standard sieve opening through which the entire amount of the aggregate is permitted to pass. Standard sieve sizes shall be those listed in ASTM C 33.

The Owner may sample each component aggregate prior to introduction to the weigh batcher or as otherwise determined by the Engineer. Each separate component will be sieve analyzed alone per AASHTO Test Method T-11/27. All material components will be mathematically re-combined by proportions (Weighted Average), supplied by the Contractor.

9-03.1(5) COARSE AGGREGATES FOR PERVIOUS CONCRETE

9-03.1(5)A GENERAL

Aggregate for pervious concrete shall meet the requirements of Sections 9-03.1(3)A, 9-03.1(3)B and 9-03.1(3)C.

9-03.1(5)B GRADING

Aggregate for pervious concrete shall conform to one of the following gradations:

% - TOTAL PERCENT PASSING BY WEIGHT	AGGREGATE GRADATION	
	AASHTO NO. 8 SIZE AGGREGATE GRADATION	
SIEVE SIZE	MIN.	MAX.
1/2” Square	100%	---
3/8” Square	85%	100%
U.S. No. 4	10%	30%
U.S. No. 8	0%	10%
U.S. No. 16	0%	5%
U.S. No. 50	---	---
U.S. No. 200	0%	0.5%

In individual tests, a variation of four (4) percent under the minimum percentages or over the maximum percentages will be allowed on sieves size No. 16 and larger. For sieves smaller than No. 16, the maximum percentage passing shall not exceed the limits shown for any single test. The average of three successive tests shall be within the percentages stated above. Coarse aggregate shall contain no pieces larger than two (2) times the maximum sieve size for the specified grading measured along the line of greatest dimension.

Acceptance of grading and quality of the aggregate will be based on samples taken from stockpiles at the concrete plant. The exact point of acceptance will be determined in the field by the Engineer.

When the Engineer accepts, the pervious concrete aggregate may be blended from other sizes if:

The resulting aggregate meets all requirements for the specified grading;

Each size used makes up at least five (5) percent of the blend;

The Contractor supplies the Engineer with the gradation for the proposed sizes, along with their proper proportions before producing the aggregate. If the aggregate comes from commercial sources, the Contractor shall supply this information and have it accepted before proportioning and mixing the concrete.

9-03.2 AGGREGATE FOR BIORETENTION SOIL

9-03.2(1) GENERAL

In general, soil aggregate shall be free of wood, waste, coating, or any other deleterious material, and all aggregate passing the No. 200 sieve size shall be non-plastic.

9-03.2(2) MINERAL AGGREGATE FOR BIORETENTION SOIL

Sieve Analysis. Mineral Aggregate for Bioretention Soils shall be analyzed by an accredited lab using the sieve sizes noted below, and shall meet the following gradation:

Sieve Size	Percent Passing
3/8”	100

o. 4	60 - 100
No.10	40 - 100
No. 40	15 - 50
No. 200	2 - 5

9-03.3 STREAMBED AGGREGATE

9-03.3(1) QUALITY

Aggregates for streambed construction shall be washed, naturally formed, round to sub angular hard, strong, sound, durable, fracture free pieces of igneous and metamorphic rock. Aggregate shall be free of soft, weathered materials and seams of soft rock, shall not contain any wood and other waste, and shall be free of any coating.

The Contractor shall submit certified test reports indicating streambed aggregate complies with the following requirements:

All sand size aggregate (passing a U.S. No. 4 sieve and retained on a US No. 200 sieve) shall meet the following requirements:

Specific Gravity	AASHTO T 84	Minimum 2.65

All gravel (passing a 3 inch sieve and retained on a U.S. No. 4 sieve) and cobble (passing a 12 inch sieve and retained on a 3 inch sieve) aggregate shall meet the same requirements for sand size aggregate and the following additional requirements:

Soundness	ASTM C 88	Not greater than 5% loss
L.A. Abrasion	AASHTO T 96	Max 20% loss at 500 revolutions

All boulder size aggregate (retained on a 12 inch screen) shall meet the same requirements for gravel and cobble and the following additional requirements:

Accelerated expansion	CRD-C-148	Not greater than 15% breakdown
Absorption	AASHTO T 85	Not greater than 2%

9-03.3(2) GRADATIONS

Aggregate gradations for streambed construction shall be on a weight basis and shall be as follows:

STREAMBED AGGREGATE TYPE 1	
SIEVE SIZE	**PERCENT PASSING**
8 inch	95 – 100
3” square	45 – 60
1 ½” square	30 – 40
¾” square	10 – 20
U.S. No. 4	0 – 3

The portion passing the U.S. No. 4 sieve size shall have a minimum sand equivalent of 60.

STREAMBED AGGREGATE TYPE 2	
SIEVE SIZE	**PERCENT PASSING**
16 inch	95 - 100
8 inch	55 - 75
3 inch	20 - 35
1 ½ inch	0 - 15
¾ inch	0 - 5

STREAMBED AGGREGATE TYPE 3

SIEVE SIZE	PERCENT PASSING
32 inch	95 - 100
24 inch	60 - 75
16 inch	40 - 55
8 inch	10 - 20
3 inch	0 - 10
¾ inch	0 - 2

9-03.4 AGGREGATE FOR BITUMINOUS SURFACE TREATMENT

9-03.4(1) GENERAL REQUIREMENTS

Aggregate for bituminous surface treatment shall be manufactured from ledge rock, talus, or gravel, in accordance with Section 3-01, which meets the following test requirements:

Los Angeles Wear, 500 Rev.	35% max.
Degradation Factor	30 min.

9-03.4(2) GRADING AND QUALITY

Aggregate for bituminous surface treatment shall conform to the requirements in the following table for grading and quality. The particular type or grading to be used shall be as shown on the Drawings. All percentages are by weight.

The Material shall meet the requirements for grading and quality when placed in hauling vehicles for delivery to the roadway, or during manufacture and placement into a temporary stockpile. The exact point of acceptance will be determined by the Engineer.

	PERCENT PASSING					
SIEVE SIZE	CRUSHED COVER STONE	3/4"- 1/2"	5/8"- U.S. NO. 4	1/2"- U.S. NO. 4	3/8"- #10	U.S. NO. 4- 0"
1" square	100	100	---	---	---	---
3/4" square	100	95-100	100	---	---	---
5/8" square	95-100	---	95-100	100	---	---
1/2" square	---	0-20	---	95-100	100	---
3/8" square	---	0-5	---	---	90-100	100
U.S. No. 4	20-45	---	0-10	0-15	30-56	76-100
U.S. No. 10	---	---	0-3	0-3	0-10	30-60
U.S. No. 200	0-7.5	0-1.0	0-1.0	0-1.0	0-1.0	0-10.0
% fracture, by weight, min.	90	90	90	90	90	90
Sand equivalent min.	40	---	---	---	---	---
Static Stripping Test	Pass	Pass	Pass	Pass	Pass	Pass

The fracture requirement shall be at least one fractured face and applies to Material retained on each sieve size U.S. No. 4 and above if that sieve retains more than 5 percent of the total sample.

The finished product shall be clean, uniform in quality, and free from wood, bark, roots, clay, any organic material, and other deleterious materials.

Crushed screenings shall be substantially free from adherent coatings. The presence of a thin, firmly adhering film of weathered rock shall not be considered as coating unless it exists on more than 50 percent of the surface area of any size between successive laboratory sieves.

The portion of aggregate for bituminous surface treatment retained on the U.S. No. 4 sieve shall not contain more than 0.1 percent deleterious materials by weight.

9-03.5 RESERVED

9-03.6 AGGREGATES FOR ASPHALT TREATED BASE (ATB)

9-03.6(1) GENERAL REQUIREMENTS

Aggregates for asphalt treated base shall be manufactured from ledge rock, talus, or gravel, in accordance with the provisions of Section 3-01 that meet the following test requirements:

Los Angeles Wear, 500 Rev.	30% max.
Degradation Factor, Wearing Course	15 min.

9-03.6(2) GRADING

Aggregates for asphalt treated base shall meet the following requirements for grading:

SIEVE SIZE	PERCENT PASSING
2" square	100
½" square	56-100
U.S. No. 4	32-72
U.S. No. 10	22-57
U.S. No. 40	8-32
U.S. No. 200	2.0-9.0

9-03.6(3) TEST REQUIREMENTS

When the aggregates are combined within the limits set forth in Section 9-03.6(2) and mixed with the designated grade of asphalt, the mixture shall be Capable of meeting the following test values:

% of Theoretical Maximum Specific Gravity (G_{MM}) (approximate)	93 @ 100 gyrations
Tensile Strength Ratio Test	50 min. / no visual damage

The sand equivalent value of the Mineral Aggregate for asphalt treated base shall not be less than 35.

9-03.7 RESERVED

9-03.8 AGGREGATES FOR HOT MIX ASPHALT (HMA)

9-03.8(1) GENERAL REQUIREMENTS

Aggregates for hot mix asphalt shall be manufactured from ledge rock, talus, or gravel, in accordance with the provisions of Section 3-01, shall meet the following test requirements:

Los Angeles Wear, 500 Rev.	30% max.
Degradation Factor, Wearing Course	30 min.
Degradation Factor, Other Courses	20 min.

The aggregate shall be uniform in quality, and shall be free from wood, roots, bark, extraneous materials, and adherent coatings. The presence of a thin, firmly adhering film of weathered rock will not be considered as coating unless it exists on more than 50 percent of the surface area of the aggregate retained on any size sieve.

Aggregate removed from deposits contaminated with various types of wood waste shall be washed, processed, selected, or otherwise treated to remove sufficient wood waste so that the oven dried material retained on a U.S. No. 4 sieve shall not contain more than 0.1 percent by weight of material with a specific gravity less than 1.0.

9-03.8(2) HMA TEST REQUIREMENTS

Aggregate for HMA shall meet the following test requirements:

1. The aggregate shall meet the Flat and Elongated shape requirements, measured as percent by weight of flat-elongated in accordance with ASTM D 4791. The percent shall not exceed 10 percent and the ratio shall be 5:1.

2. The fracture requirements for the combined coarse aggregate in the table below shall apply to the aggregate retained on each sieve U.S. No. 4 and larger when tested in accordance with AASHTO T 335:

"DESIGN ESALS" (MILLIONS)	NO. FRACTURED FACES	% FRACTURE
<10	1	90
≥ 10	2	90

3. The uncompacted void content for the combined fine aggregate is tested in accordance with Test Method for AASHTO T 304, Method A. The minimum voids shall be 45%.

4. The minimum sand equivalent shall be 45.

During verification by the Laboratory, the mix design shall produce HMA mixtures that when combined within the limits set forth in Section 9-03.8(6) and mixed with the designated grade of asphalt binder, using the Superpave gyratory compactor in accordance with AASHTO T 312, and at the required gyrations for N design with the following properties:

	HMA CLASS							
	3/8 INCH		1/2 INCH		¾ INCH		1 INCH	
HMA MIX CRITERIA	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
Voids in Mineral Aggregate (VMA), %	15.0		14.0		13.0		12.0	
ESAL'S (MILLIONS)	VOIDS FILLED WITH ASPHALT (VFA), %							
< 0.3	70	80	70	80	70	80	67	80
0.3 to < 3	65	78	65	78	65	78	65	78
3 to < 10	73	76	65	75	65	75	65	75
10 to < 30	73	76	65	75	65	75	65	75
≥ 30	73	76	65	75	65	75	65	75
Dust / Asphalt Ratio	0.6	1.6	0.6	1.6	0.6	1.6	0.6	1.6
Tensile Strength Ratio	80 min. / no visible damage							
	ESAL'S (MILLIONS)		$N_{INITIAL}$		N_{DESIGN}		$N_{MAXIMUM}$	
% G_{mm}	< 0.3		≤ 91.5		96.0		≤ 98.0	
	0.3 to < 3		≤ 90.5		96.0		≤ 98.0	
	≥ 3		≤ 89.0		96.0		≤ 98.0	
Gyratory Compaction (number of gyrations)	< 0.3		6		50		75	
	0.3 to < 3		7		75		115	
	3 to < 30		8		100		160	
	≥ 30		9		125		205	

During the production run of each approved JMF, the HMA will not be evaluated for VMA or VFA for quality assurance purposes. The fine aggregate angularity, flat and elongated particles, fracture and sand equivalent requirements shall apply at the time of HMA production.

9-03.8(3) GRADING

9-03.8(3)A GRADATION

The Contractor may furnish aggregates for use on the same Contract From a single stockpile or from multiple stockpiles, as long as all aggregate is from the same source. The gradation of the aggregates, including any use of RAP, mineral filler, and blending sand, shall be such that the completed mixture complies in all respects with the pertinent requirements of Section 9-03.8(6).

Acceptance of the aggregate gradation will be based on samples taken from the final mix.

9-03.8(3)B RECYCLED ASPHALT PAVEMENT (RAP)

Asphalt concrete planings or old asphalt concrete utilized in the production of asphalt concrete shall be sized prior to entering the mixer so that a uniform and thoroughly mixed asphalt concrete is produced in the mixer. If there is evidence of the old asphalt concrete not breaking down during the heating and mixing of the asphalt concrete, the Engineer may elect to

modify the maximum size entering the mixer. No contamination by deleterious materials will be allowed in the old asphalt concrete used.

RAP may be added to the mix in the proportions described in Section 5-04.2(1). The gradation for the new aggregate used in the production of the asphalt concrete shall be the responsibility of the Contractor, and when combined with recycled material, the combined material shall meet the gradation specification requirements for the specified class of HMA as listed in Section 9-03.8(6) and 9-03.8(7) unless the Contract specifies otherwise. The new aggregate shall meet the general requirements listed in Section 9-03.8(1) and shall meet the appropriate fracture requirements specified in Section 9-03.8(2) item 2 for coarse aggregate, and sand equivalent requirements specified in Section 9-03.8(2) and in Section 9-03.8(4) for blending sand.

9-03.8(3)C RECYCLED PORLAND CEMENT CONCRETE RUBBLE AND STEEL FURNACE SLAG

Recycled portland cement concrete rubble and/or steel furnace slag may be blended with virgin aggregates in the proportions shown in Section 9-03.18(1)E. The proportion of each of these materials in the mix will be considered independently and not cumulatively. The final mix shall meet all of the requirements of Section 9-03.8. Recycled portland cement concrete rubble and steel furnace slag shall meet the requirements of Sections 9-03.18(1)B and 9-03.18(1)D respectively.

The Contractor shall indicate on the mix design submittal the percentage of each in the proposed mix design.

9-03.8(4) BLENDING SAND

Blending sand shall be clean, hard, sound material, either naturally occurring sand or crusher fines, and must be material which will readily accept an asphalt coating. The exact grading requirements for the blending sand shall be such that, when it is mixed with an aggregate, the combined product shall meet the requirements of Section 9-03.8(6) for the class of HMA involved. Blending sand shall meet the following quality requirement:

Sand Equivalent 30 min.

9-03.8(5) MINERAL FILLER

Mineral filler, when used in HMA, shall conform to the requirements of AASHTO M 17.

9-03.8(6) HMA PROPORTIONS OF MATERIALS

The materials of which HMA is composed shall consist of such sizes, grading, and quantity that when proportioned and mixed together, produce a well graded mixture meeting the requirements that follow.

The Contractors HMA mix design shall be between the control points.

HMA AGGREGATE GRADATION CONTROL POINTS				
	PERCENT PASSING			
SIEVE SIZE	HMA CLASS 3/8 INCH	HMA CLASS ½ INCH	HMA CLASS 3/4 INCH	HMA CLASS 1 INCH
1 ½” square				100
1” square			100	90-100
3/4” square		100	90-100	90 Maximum
1/2” square	100	90 – 100	90 Maximum	
3/8” square	90 – 100	90 Maximum		
U.S. No. 4	90 Maximum			
U.S. No. 8	32 – 67	28 - 58	23 – 49	19-45
U.S. No. 200	2.0 – 7.0	2.0 – 7.0	2.0 – 7.0	1.0-7.0

The aggregate percentage refers to completed dry mix, and includes mineral filler when used.

9-03.8(7) HMA TOLERANCES AND ADJUSTMENTS

1. **Job Mix Formula Tolerances.** After the JMF is determined as required in 5-04.3(7)A, the constituents of the mixture at the time of acceptance shall conform to the following tolerances:

AGGREGATE, PERCENT PASSING[1]	TOLERANCE
1”, 3/4”, 1/2” and 3/8” sieves	± 6% each sieve
U.S. No. 4 sieve	± 6%

U.S. No. 8 sieve	± 6%
U.S. No. 200 sieve	± 2.0%
Asphalt binder	± 0.5%
VMA[2]	1% below minimum value in Section 9-03.8(2)
VFA[2]	min. and max. as listed in Section 9-03.8(2)
V_a[3]	2.5% minimum and 5.5% maximum

Notes:

1. The tolerance limit for aggregate shall not exceed the limits of the control points specified in Section 9-03.8(6), except the tolerance limits for sieves designated as 100% passing shall be 99-100. The tolerance limits on sieves shall only apply to sieves with control points.

2. The tolerances for VMA and VFA are for mix verification only.

3. The tolerance for V_a is for mix verification and acceptance.

2. **Job Mix Formula Adjustments:** Adjustments beyond the limits below require approval by the Engineer and shall require the development of a new mix design.

   A. Aggregates: The Engineer may approve the Contractor's written request to adjust the JMF. The maximum adjustment from the approved mix design shall be 2 percent for the aggregate retained on the U.S. No. 8 sieve and above, 1 percent for aggregate passing the U.S. No. 8 sieve, and 0.5 percent for the aggregate passing the U.S. No. 200 sieve. These field adjustments to the JMF will only be considered if the changes produce material of equal or better quality. The adjusted JMF and allowed tolerances shall be within the range of the control points listed in Section 9-03.8(7). V_a of the adjusted JMF shall remain within the limits shown shown above.

   B. Asphalt Binder Content: The Engineer may order the Contractor, or may approve the Contractor's written request, to change the JMF asphalt binder content a maximum of 0.3 percent from the approved mix design.

9-03.9 AGGREGATES FOR BALLAST AND CRUSHED SURFACING

9-03.9(1) BALLAST

Roadway ballast shall be manufactured from ledge rock or talus obtained from sources approved by the Engineer. Roadway ballast shall meet the requirements of Section 9-03.16 for Mineral Aggregate Type 14.

That portion of roadway ballast retained on a 1/4 inch square sieve shall not contain more than 0.2 % wood waste.

The Material from which ballast is to be manufactured shall have a Degradation Value not less than 15 when tested in accordance with WSDOT Test Method T 113.

Mineral Aggregate Type 1 or Type 2 may be substituted for roadway ballast in lieu of Mineral Aggregate Type 14 when specified in the Contract.

Ballast shall be a crushed Material with no naturally occurring surfaces. The term, "ballast" shall apply to Material retained on each sieve size U.S. No. 4 and above if that sieve retains more than 5 percent of the total sample.

9-03.9(2) SHOULDER BALLAST

Shoulder ballast shall meet the requirements of Section 9-03.9(1) for ballast except the gradation shall meet the requirements of Section 9-03.16 for Mineral Aggregate Type 13. The sand equivalent and dust ratio requirements shall not .apply; however, the L. A. Abrasion and Degradation Factor requirements shall apply.

9-03.9(3) CRUSHED ROCK

Except as otherwise specified in the remainder of this Section, crushed rock shall be manufactured from ledge rock or talus and shall meet the grading, sand equivalent, and L. A. Abrasion requirements of Section 9-03.16 for Mineral Aggregate Type 1, Type 2, and Type 3.

Crushed rock shall have a Degradation Value of not less than 25 when tested in accordance with WSDOT Test Method T 113.

Crushed rock shall be a totally crushed Material with no naturally occurring faces and shall apply to Material retained on each sieve size No. 10 and above if that sieve retains more than 5 percent of the total sample. Crushed rock material retained on a No. 4 sieve shall contain no more than 0.15 percent by weight of wood waste.

See Section 4-04.2 for possible use of other Mineral Aggregates in lieu of Crushed Rock, Mineral Aggregates Type 1 and Type 2.

9-03.9(4) MAINTENANCE ROCK

Maintenance rock shall meet all requirements of Section 9-03.9(3) for crushed surfacing top course except that it shall meet the specifications for grading shown for Mineral Aggregate Type 3 in Section 9-03.16.

9-03.9(5) SAND FILLER

Sand filler shall be natural deposit angular grains complying with Mineral Aggregate Type 11 per Section 9-03.16.

9-03.10 AGGREGATE FOR GRAVEL BASE

Gravel base shall meet the requirements of Section 9-03.12(2) for Mineral Aggregate Type 17.

9-03.11 CRUSHED GRAVEL

Crushed gravel shall be manufactured from mechanically crushed clean, washed gravel, and shall meet the grading, sand equivalent, and L. A. Abrasion requirements of Section 9-03.16 for Mineral Aggregate Types 1G, 2G, and 21 through 24.

MINERAL AGGREGATE TYPE	NUMBER OF FRACTURED SURFACES	MINIMUM PERCENT REQUIRED
1G	2 or more	90%
2G	2 or more	90%
21	1 or more	75%
22	2 or more	90%
23	1 or more	75%
24	2 or more	95%

These fracture requirements shall apply to aggregates retained on all sieves sized U.S. No. 4 and larger, retaining at least 5 percent of total Mineral Aggregate weight.

See Section 4-04.2 for possible use of other Mineral Aggregates in lieu of Crushed Gravel, Mineral Aggregates.

Crushed gravel and crushed rock shall be substantially free from adherent coatings. The presence of a thin, firmly adhering film of weathered rock shall not be considered as coating unless it exists on more than 50 percent of the surface area of any size between successive laboratory sieves.

The combined portion of Mineral Aggregate retained on the U.S No. 4 sieve shall not contain more than 0.1 percent wood waste by weight. The portion of Material passing a U.S. No. 10 sieve shall not have wood waste that results in more than 250 parts per million of organic matter by calorimetric tests when tested. The color shall be measured after the sample has been in the test solution for 1 hour.

If Mineral Aggregates Type 1R and Type 2R is used as base course under asphalt concrete pavement or other non-rigid pavement, then the Mineral Aggregate shall have a minimum CBR (California Bearing Ratio) of 70 per AASHTO T 193 (ASTM D1883).

9-03.12 PIT RUN SAND, WASHED SAND, AND GRAVEL BACKFILL

Gravel backfill shall consist of crushed, partially crushed, or naturally occurring granular Material depending on the Type of Mineral Aggregate specified in the Contract.

9-03.12(1) GRAVEL BACKFILL FOR FOUNDATIONS

9-03.12(1)A CLASS A BACKFILL

Class A gravel backfill for foundations shall meet the requirements of Section 9-03.9 and 9-03.16 for Type 2 or Type 14 Mineral Aggregates. When not specified in the Contract, Class A gravel backfill shall be Mineral Aggregate Type 2.

9-03.12(1)B CLASS B BACKFILL

Class B gravel backfill for foundations shall be Mineral Aggregates Type 17 or Type 27 per Section 9-03.16.

9-03.12(2) GRAVEL BACKFILL FOR WALLS

Gravel backfill for walls shall consist of free draining sand and gravel from naturally occurring or screened sources; have such characteristics of size and shape that it readily compacts; and meets the requirements of Section 9-03.16 for Mineral Aggregate Type 17.

The combined portion of Material retained on a U.S. No. 4 sieve shall contain no more than 0.20 percent by weight of wood waste.

Gravel backfill for Mechanically Stabilized Earth (MSE) walls shall be as speicified in the Contract.

9-03.12(3) GRAVEL AND SAND BACKFILL FOR PIPE BEDDING

The Contract specified class of Sewer and Storm Drain pipe bedding shall comply with both Standard plan no. 285 and Section 7-17.3(1)B, and shall be Mineral Aggregate Type 9 and Type 22 as specified in this Section and Section 9-03.16.

Water Main distribution pipe bedding Material shall meet the requirements of Section 9-03.16 for Mineral Aggregates Type 6 or Type 7 and Section 9-03.1(2). Water Main transmission pipe bedding shall meet the requirements of Section 9-03.16 for Mineral Aggregate Type 9 as shown on Standard Plan no. 350 and this Section. The bedding Class specified on the Drawings shall be as shown on Standard Plan no. 350.

Pea gravel bedding, Mineral Aggregate Type 9, shall consist of screened sand, gravel, or other inert Materials, or combinations thereof, from sources approved by the Engineer, and shall have hard, strong, durable particles free from adherent coatings. The Material shall be washed thoroughly to remove clay, loam, alkali, organic matter, or other deleterious substances. The amount of deleterious substances remaining in the washed pea gravel shall not exceed values specified in Section 9-03.1(2)B.

Crushed gravel bedding, Mineral Aggregate Type 22 shall be manufactured from screened crushed gravel. The finished product shall be clean, uniform in quality, and free from wood, bark, roots, and other deleterious Materials. The crushed screenings shall be substantially free from adherent coatings. The presence of a thin, firmly adhering film of weathered rock shall not be considered as coating unless it exists on more than 50 percent of the surface area of any size between successive laboratory sieves. The portion of Mineral Aggregate Type 22 retained on a U.S. No. 4 sieve shall not contain more than 0.1 percent deleterious Materials by weight.

9-03.12(4) GRAVEL BACKFILL FOR DRAINS

Gravel backfill for drains shall meet the requirements for Mineral Aggregate Type 26 in Section 9-03.12(6).

9-03.12(5) PIT RUN SAND AND GRAVEL

Pit run sand and gravel shall consist of free draining granular Materials obtained from naturally occurring deposits or manufactured from screened gravel.

Pit run sand shall meet the requirements of Section 9-03.16 for Mineral Aggregate Type 10.

Pit run sandy gravel shall meet the requirements of Section 9-03.16 for Mineral Aggregate Type 15.

9-03.12(6) WASHED SAND AND GRAVEL

Washed sand and gravel shall meet the gradation requirements of Section 9-03.16 for Mineral Aggregate Types 4, 5, 6, 7, 26, and 28, whichever is specified in the Contract.

Washed sand and gravel shall consist of screened sand, gravel or other inert Materials, or combinations thereof, from sources approved by the Engineer, having hard, durable particles free from adherent coatings. The Materials shall be washed thoroughly to remove clay, loam, alkali, organic matter, or other deleterious substances. The amount of deleterious substances in the washed sand or gravel shall not exceed the values specified in Section 9-03.1(2)B for Mineral Aggregate Types 6, 7, 26, and 28 and Section 9-03.1(3)B for Mineral Aggregate Types 4 and 5.

9-03.12(7) QUARRY RUN CRUSHED ROCK

Quarry run crushed rock shall:

1. be Mineral Aggregate Type 27 meeting the gradation, sand equivalent, dust ratio, and L.A. abrasion requirements of Section 9-03.16,
2. be 100% crushed,
3. have a plasticity index of 4 maximum, and
4. be free of wood and organic matter.

Mineral Aggregate Type 27 may be used as specified in the Contract as a select fill. Also see Section 9-03.12(1)B.

9-03.13 BACKFILL FOR SAND DRAIN

9-03.13(1) SAND DRAIN BACKFILL

Sand drain backfill shall conform to the following gradation (Note - not a Mineral Aggregate Type in Section 9-03.16):

SIEVE SIZE	PERCENT PASSING
1/2" square	90 – 100
U.S. No. 4	58 – 100
U.S. No. 10	40 – 100
U.S. No. 50	3 – 30
U.S. No. 100	0 – 4
U.S. No. 200	0 - 3.0

9-03.13(2) SAND DRAINAGE BLANKET

Aggregate for the sand drainage blanket shall consist of granular Material, free from wood and other extraneous Material and shall meet the following requirements for grading (Note – not a Mineral Aggregate Type in Section 9-03.16):

SIEVE SIZE	PERCENT PASSING
2-1/2" square	90 – 100
U.S. No. 4	23 – 100

The portion passing the U.S. No. 4 sieve shall meet the following requirements for grading:

SIEVE SIZE	PERCENT PASSING
U.S. No. 10	50 - 100
U.S. No. 50	0 - 30
U.S. No. 100	0 - 7.0
U.S. No. 200	0 - 3.0

That portion of backfill for sand drains and sand drainage blanket retained on the U.S. No. 4 sieve shall contain not more than 0.05 percent by weight of wood waste.

9-03.14 GRAVEL BORROW

Unless otherwise specified in the Contract, gravel borrow shall meet the requirements of Section 9-03.12(2) and the grading requirements in Section 9-03.16 for Mineral Aggregate Type 17.

If requested by the Contractor, the screen size may be increased if it is determined by the Engineer that larger size aggregate will be acceptable for the specified backfilling or embankment construction.

9-03.15 TEST METHODS FOR AGGREGATES

Material properties in these Specifications shall be determined in accordance with the following test methods:

TITLE	TEST METHOD
Sampling of Aggregates	AASHTO T 2
Organic Impurities in Fine Aggregate for Concrete	AASHTO T 21
Clay Lumps and Friable Particles in Aggregates	AASHTO T 112
Resistance to Degradation of Small-Size Coarse Aggregates by Abrasion and Impact in the Los Angeles Machine	AASHTO T 96
Material Finer than U.S. No. 200 Sieve in Aggregates	AASHTO T 11
Percent Fracture in Coarse Aggregates	AASHTO T 335
Sieve Analysis of Fine and Coarse Aggregates	AASHTO T 27
Method of Test for Determination of Degradation Value	WSDOT T 113
Lightweight Pieces in Aggregates	AASHTO T 113
Flat and Elongated Particles in Coarse Aggregate	ASTM D 4791
Sand Equivalent	AASHTO T 176
Determination of Length Change of Concrete Due to Alkali-Silica Reaction	ASTM C 1293

Petrographic Examination of Aggregates for Concrete	ASTM C 295
Determining the Potential Alkali-Silica Reactivity of Combination of Cementitious Materials and Aggregate (Accelerated Mortar Bar Method)	ASTM C 1567
Specific Gravity and Absorption of Coarse Aggregate	AASHTO T 85
Specific Gravity and Absorption of Fine Aggregate	AASHTO T 84
Determining the Liquid Limit of Soils	AASHTO T 89
Determining the Plastic Limit and Plasticity Index of Soils	AASHTO T 90
Soundness of Aggregates by Use of Sodium Sufate or Magnesium Sulfate	AASHTO T 104
Method of Testing Stone for Expansive Breakdown on Soaking in Ethylene Glycol	CRD-C 148
Resistance of Compacted Hot Mix Asphalt (HMA) to Moisture Induced Damage	AASHTO T 283
Uncompacted Void Content of Fine Aggregate	AASHTO T 304
Preparing and Determining the Density of the Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor	AASHTO T 312
Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt (HMA)	AASHTO T 209
Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method	AASHTO T 308
Standard Test Method for Potential Expansion of Aggregates from Hydration Reactions	ASTM D 4792

9-03.16 MINERAL AGGREGATE CHART

Commonly used mineral aggregates can be found in the following Mineral Aggregate Chart. The "No." indicated at the top of column 1 is commonly referred to as Mineral Aggregate "Type" number.
Gradation requirements for Mineral Aggregates Type 6 and Type 7 indicated on the following Mineral Aggregate Chart require additional sieves. These Mineral Aggregate Types are noted with a "*****" in the first column labeled "No.". See the specified "Standard Specification Section" for these noted additional required sieves.

MINERAL AGGREGATE CHART

NO.	Aggregate Type	Use	Standard Specification Section	SIEVE SIZES SIEVE ANALYSIS-PERCENT PASSING BY WEIGHT																Sand Equivalent (Min.)	Dust Ratio (Max.)	L.A. Abrasion (Max.) %
				200 (wet sieving)	50	40	10	8	6	4	3/8	1/2	5/8	3/4	1	1-1/4	1-1/2	2	2-1/2	3			
1.	3/4" Minus Crushed Rock	Top Course & Keystone	9-03.9(3)	0-10	....	8-24	....	....	....	46-66	....	....	….	100	....	....	....	....	....	....	40	....	35
1G.	3/4" Minus Crushed Gravel	Top Course & Keystone	9-03.11	0-10	....	8-24	....	....	....	46-66	....	....	….	100	....	....	....	....	....	....	40	....	35
2.	1-1/4" Minus Crushed Rock	Base Course	9-03.9(3) 9-03.12(1)	0-7.5	....	3-18	....	....	....	25-45	....	....	50-80	....	80-100	100	....	....	....	....	40	....	35
2G.	1-1/4" Minus Crushed Gravel	Base Course	9-03.11	0-7.5	....	3-18	....	....	....	25-45	....	....	50-80	....	80-100	100	....	....	....	....	40	....	35
3.	Maintenance Rock		9-03.9(3) 9-03.9(4)	0-7	....	10-25	....	....	....	45-66	....	90-100	100	....	....	....	....	....	....	....	40	....	35
4.	1-1/2" Washed Gravel	Drain Rock AASHTO #4	9-03.12(6)	0-0.5	....	....	....	....	....	....	0-5	....	....	0-15	20-55	….	90-100	100	....	....	....	....	35
5.	1" Washed Gravel	Drain Rock AASHTO #57	9-03.12(6)	0-0.5	0-1	....	....	0-5	....	0-10	….	25-60	....	….	95-100	....	100	....	....	....	....	....	35
6.	Washed Sand		9-03.1(2)C	0-2.5	9-20	....	....	68-86	….	95-100	100	....	....	....	....	....	....	....	....	....	....	....	....
7.	Building Sand		9-03.1(2)C	0-2.5	10-30	....	....	….	….	95-100	100	....	....	....	....	....	....	....	....	....	....	....	....
9.	3/8" Washed Gravel	Pipe Bedding AASHTO #8	9-03.12(3)	0-1	....	....	....	0-10	....	10-30	80-100	....	....	….	....	....	....	....	....	....	....	....	35
10.	Pit Run Sand	Backfill Embankment	9-03.12(5)	0-10	10-60	....	....	40-100	....	75-100	100	....	....	....	....	....	....	....	....	....	....	....	....
11.	Sand Filler		9-03.9(5)	0-15	....	15-40	40-75	....	....	80-100	100	....	....	....	....	....	....	....	....	....	....	....	....
13.	2-1/2" Minus Crushed Rock	Shoulder Ballast	9-03.9(2)	0-1	....	....	....	....	....	0-5	....	....	....	40-80	....	....	....	65-100	100	....	....	....	40
14.	2-1/2" Crushed Rock	Roadway Ballast	9-03.9(1) 9-03.12(1)	0-9	....	0-16	....	....	....	26-44	....	....	....	....	50-85	....	....	65-100	100	....	35	2/3	40
15.	Pit Run Sandy Gravel	Backfill Embankment	9-03.12(5)	0-10	....	....	....	....	....	19-38	....	....	....	100	....	....	....	....	....	....	....	....	30
17.	Bank Run Gravel	Selected Backfill	9-03.10 9-03.12(2) 9-03.14	0-5	....	....	....	....	....	24-71	....	....	....	....	....	....	....	....	....	95-100	60	2/3	....
21.	1-1/2" Crushed Gravel		9-03.11	0-3	....	....	....	....	....	0-24	....	45-70	85-100	....	....	....	100	....	....	....	....	....	30
22.	3/4" Crushed	VCP, PVC &	9-03.11	0-3	....	....	....	....	....	0-24	....	45-100	….	100	....	....	....	....	....	....	....	....	.....

	Gravel	CMP Pipe Bedding	9-03.12(3)																			
23.	1/2" Minus Crushed Gravel	Cover Rock	9-03.11	2-12	....	....	40-75	....	....	63-100	....	100	....	....	....	....	....	....	....	....	....	....	30
24.	1/2" Minus Crushed Gravel	Chip Rock	9-03.11	0-3	....	0-5	0-10	....	0-20	25-85	90-100	100	....	....	....	....	....	....	....	....	....	....	30
26.	3/4" Washed Sandy Gravel	Filter Material	9-03.12(4)	0-1	3-12	....	....	20-50	....	28-56	....	....	....	100	....	....	....	....	....	....	....	....	35
27.	Quarry Run Crushed Rock	Select Fill	9-03.12(7)	0-15	….	0-50	….	….	….	20-70	….	….	….	70-100	….	….	….	100	….	….	25	2/3	35
28.	3/4" Washed Gravel	Drain Rock AASHTO #67	9-03.12(6)	0-1	….	….	….	0-5	….	0-10 ….	20-55	….	….	90-100	100	….	….	….	….	….	….	….	35

9-03.17 ROCK FACING MATERIAL

Rock for constructing new rock facing shall be large, broken pieces of igneous and metamorphic rock types. Each rock shall be rectangular, intact, fracture free, sound and durable Material, resistant to weathering and free of soft weathered Material and seams of soft rock susceptible to deterioration.

The size categories for rock shall be as follows:

SIZE	APPROX. WEIGHT	MIN. APPROX. DIMENSIONS	APPROX. VOLUME
One-man rock	200 – 400 lbs.	12 inches	2 cf
Two-man rock	500 – 800 lbs.	13 inches	4 cf
Three-man rock	900 – 1200 lbs.	16 inches	6.6 cf
Four-man rock	1300 - 2000 lbs.	18 inches	12.5 cf
Five-man rock	2000 – 4000 lbs.	24 inches	18.5 cf
Six-man rock	4100 – 6000 lbs.	30 inches	31 cf

Rocks less than 1.5 cubic foot (cf) in volume shall not be used.

The Contractor shall provide the services of an ASTM or AASHTO accredited testing laboratory approved by the Engineer to sample the rock from the quarry source, ensuring that rock samples are representative of the rock anticipated for use on the project, and to perform the following laboratory tests:

Specific Gravity	ASTM C 127	Minimum 2.65
Soundness	AASHTO T 104 (section 5.2.2)	Not greater than 5 % loss
Accelerated Expansion	CRD-C-148	Not greater than 15% breakdown
Absorption	ASTM C 127	Not greater than 2%
L. A. Abrasion	ASTM C 131	Maximum 20% loss @ 500 revolutions

All rock to be delivered to and incorporated into the project where rock facing is over 6 feet high, shall meet the minimum testing requirements noted above; the rock shall be stockpiled in a separate pile at the quarry prior to delivery to the Project Site and shall be protected from contamination with other, untested rock sources.

9-03.18 RECYCLED MATERIAL

9-03.18(1) GENERAL REQUIREMENTS

Recycled materials that are identified below may be used in lieu of, or blended uniformly with, naturally occurring materials for aggregates in the percentages shown in Section 9-03.18(1)E. The final blended product shall meet the requirements for the specified type of aggregate. In addition, each recycled material component included in a blended product, shall meet the specific requirements listed below. The Contractor shall provide a certification that the recycled materials are in conformance with the requirements of the Standard Specifications prior to delivery. The certification shall include the percent by weight of each recycled material.

For recycled materials that are imported to the job site, the Contractor shall certify that the recycled material is not a Washington State Dangerous Waste per the Dangerous Waste Regulations contained in WAC 173-303. Upon request of the Engineer, the Contractor shall provide results of testing supporting the certification.

9-03.18(1)A RECYCLED HOT MIX ASPHALT

For aggregates incorporating recycled hot mix asphalt, the Contractor shall verify the maximum bitumen content for the blended mix. The Contractor shall use AASHTO T 308 (0.70 may be used as a calibration factor) and AASHTO T 329 or other tests approved by the Engineer to determine the total bitumen content.

9-03.18(1)B RECYCLED PORTLAND CEMENT CONCRETE RUBBLE

Portland cement concrete rubble to be recycled into construction aggregates shall not have been painted or exposed to dangerous or hazardous substances. Steel reinforcing shall be removed and the concrete rubble shall be separated from other debris before processing.

Recycled portland cement concrete rubble shall not be used in the following situations:

1. Where it will be exposed to the elements.
2. Where free drainage is required.
3. As structural fill, including pavement base or subbase, where wet conditions exist or are anticipated to exist.

Recycled portland cement concrete rubble used as base course, fill or bedding material may contain an aggregated maximum of 20 percent by weight of asphalt concrete, brick or porcelain rubble. If used as or included in coarse aggregate for portland or hydraulic cement concrete, the recycled portland cement concrete rubble shall be free of asphalt concrete, brick or porcelain and shall meet the requirements for deleterious materials in Section 9-03.1(4)A. If used as an aggregate for hot mix asphalt, it shall have no more than five percent by weight of asphalt concrete, brick or porcelain and shall otherwise meet the requirements for deleterious substances specified in Section 9-03.8(1).

9-03.18(1)C RECYCLED GLASS CULLET

Recycled glass cullet shall be from stock composed primarily of glass food and beverage containers (soda-lime-silica) and shall not contain medical, toxic or hazardous materials. Unless otherwise stipulated in the Special Provisions, recycled glass cullet shall not be placed in whole or in any blended product within three (3) feet of any final graded surface.

The maximum debris level of the cullet shall be 5 percent. Debris is defined as any deleterious material which impacts the performance of the engineered fill and includes all non-glass constituents of the glass feedstock. The percentage of debris in cullet shall be quantified using the following visual method: Between 1 and 3 pounds of processed cullet shall be placed in a flat pan or plate, 8 to 10 inches in diameter and 1 to 2 inches in depth. The percentage of debris shall be estimated using American Geological Institute (AGI) Data Sheets 15.1 and 15.2, "Comparison Charts for Estimating Percentage Composition", 1982.

Total lead content testing shall be performed quarterly by the product supplier. Tests shall include a minimum of 5 samples. Sample collection shall be conducted according to ASTM D75. The mean of these tests shall not exceed 80 ppm. Total lead content testing will be conducted according to EPA Method 3010/6010. All test results shall be kept on file by the product supplier.

9-03.18(1)D RECYCLED STEEL FURNACE SLAG

Recycled Steel Furnace Slag shall consist of furnace or tap slag as a direct byproduct of a primary steel furnace and shall not contain dust or sludge from electric arc emission controls systems. Ladle slag, raker slag, synthetic slag, pit slag, clean out slag, or any other slag not produced in a primary steel furnace, shall not be used.

Recycled Steel Furnace Slag aggregate shall have an expansion less than 0.50 percent at 7 days when tested in accordance with ASTM D 4792. If expansion test results exceed 0.50 percent at 7 days, the Contractor shall wet condition the stockpile for a period of 6 months at a minimum moisture content of 6 percent.

Testing for expansion shall be conducted on samples at the rate of one each per 5,000 tons of material produced or once for every six months of production, whichever is more numerous. Test data and wet conditioning documentation shall be retained by the producer and relevant test data or documentation shall be submitted to the Engineer for all material proposed for incorporation into the project.

Recycled steel furnace slag shall not be used in the following situations:

1. Where it will be exposed to the elements.
2. Where free drainage is required.
3. As pavement base or subbase, where wet conditions exist or are anticipated to exist.
4. As structural fill.
5. As an aggregate for portland cement concrete.

The Contractor shall provide to the Engineer the steel furnace slag blends that will be used in the final product prior to use. No recycled steel furnace slag shall be incorporated into the project without prior approval of the Engineer.

9-03.18(1)E ALLOWABLE RECYCLED MATERIAL CONTENT

The maximum percent by weight of recycled materials that may be used to replace naturally occurring aggregates is shown in the following table:

TYPE	MATERIAL	SPECIFICATION	MAXIMUM ALLOWABLE PERCENT OF RECYCLED MATERIAL BY WEIGHT			
			HOT MIX ASPHALT	CONCRETE RUBBLE	RECYCLED GLASS CULLET	STEEL FURNACE SLAG
	Fine Aggregate for Portland Cement Concrete	9-03.1(2)	0	0	0	0
	Coarse Aggregate for Portland Cement Concrete	9-03.1(3)	0	See 9-03.1(3)E	0	0

	Bituminous Surface Treatment Aggregate	9-03.4	0	0	0	0
	Aggregate for Asphalt Treated Base	9-03.6	See 5-04.2	50	0	0
	Aggregates for Hot Mix Asphalt	9-03.8	See 5-04.2	50	0	20
1.	3/4" Minus Crushed Rock	9-03.9(3)	0	0	15	20
1G.	3/4" Minus Crushed Gravel	9-03.11	20	100	15	20
2.	1-1/4" Minus Crushed Rock	9-03.9(3) 9-03.12(1)	0	0	15	20
2G.	1-1/4" Minus Crushed Gravel	9-03.11	20	100	15	20
3.	Maintenance Rock	9-03.9(3) 9-03.9(4)	20	100	15	20
4.	1-1/2" Washed Gravel	9-03.12(6)	0	0	0	0
5.	1" Washed Gravel	9-03.12(6)	0	0	0	0
6.	Washed Sand	9-03.1(2)C	0	0	0	0
7.	Building Sand	9-03.1(2)C	0	0	0	0
9.	3/8" Washed Gravel	9-03.12(3)	0	0	0	0
10.	Pit Run Sand	9-03.12(5)	0	0	0	0
11.	Sand Filler	9-03.9(5)	0	0	0	0
13.	2-1/2" Minus Crushed Rock	9-03.9(2)	20	100	15	20
14.	2-1/2" Crushed Rock	9-03.9(1) 9-03.12(1)	20	100	15	20
15.	Pit Run Sandy Gravel	9-03.12(5)	20	100	100	20
17.	Bank Run Gravel	9-03.10 9-03.12(2) 9-03.14	20	100	100	20
21.	1-1/2" Crushed Gravel	9-03.11	0	0	15	0
22.	3/4" Crushed Gravel	9-03.11 9-03.12(3)	0	0	100	0
23.	1/2" Minus Crushed Gravel	9-03.11	20	100	15	20
24.	1/2" Minus Crushed Gravel	9-03.11	0	0	0	0
26.	3/4" Washed Sandy Gravel	9-03.12(4)	0	0	100	0
27.	Quarry Run Crushed Rock	9-03.12(7)	0	0	100	20
28.	3/4" Washed Gravel	9-03.12(6)	0	0	0	0

None of the values presented in this table shall be construed to be overriding any provision restricting the use of recycled materials included elsewhere in these specifications.

SECTION 9-04 JOINT AND CRACK SEALING MATERIALS

9-04.1 PREMOLDED JOINT FILLERS

9-04.1(1) FILLER FOR CONTRACTION JOINTS IN CEMENT CONCRETE PAVEMENT

Premolded joint filler for use in cement concrete transverse and longitudinal contraction joints shall consist of a suitable asphalt mastic encased in asphalt-saturated paper or asphalt-saturated felt. It shall be sufficiently rigid for easy installation in summer months and not too brittle for handling in cool weather. It shall meet the following test requirements:

When a strip 2 inches wide and 24 inches long is freely supported 2 inches from each end and maintained at a temperature of 70°F, it shall support a weight of 100 grams placed at the center of the strip without deflecting downward from a horizontal position more than 2 inches within a period of 5 minutes.

The thickness and width of joint filler shall be as shown in the Standard Plans unless the Contract specifies otherwise. Where no premolded joint filler thickness is indicated, the premolded filler thickness shall be 3/8 inch.

9-04.1(2) FILLER FOR THROUGH (EXPANSION) JOINTS IN CEMENT CONCRETE PAVEMENT

Premolded joint filler for through (expansion) and isolation joint applications shall conform to the specifications for "Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction", AASHTO M 213, except the requirement for water absorption is not applicable, or ASTM D 7174 Specifications for “Preformed Closed-Cell Polyolefin Expansion Joint Fillers for Concrete Paving and Structural Construction.” The thickness and width of premolded joint filler for through (expansion) joints shall be as indicated on the Standard Plans unless otherwise specified in the Contract. Where no premolded filler thickness is indicated, the thickness shall be 3/4 inch.

9-04.2 JOINT SEALANTS

9-04.2(1) HOT POURED JOINT SEALANTS

Hot poured joint sealants shall meet the requirements of AASHTO M 324 Type IV, except that the Cone Penetration at 25°C shall be 130 max. Hot poured joint sealants shall be sampled in accordance with ASTM D 5167 and tested in accordance with ASTM D 5329. The hot poured joint sealant shall have a minimum Cleveland Open Cup Flash Point of 205°C in accordance with AASHTO T 48.

9-04.2(2) POURED RUBBER JOINT SEALER

The physical properties of the joint sealer, when mixed in accordance with the manufacturer’s recommendations, shall be as follows:

1.	Color: Gray or black.	
2.	[1]Viscosity: Shall be pourable and self-leveling at 50°F.	
3.	[1]Application Life:	Not less than 3 hours at 72°F and 50 percent relative humidity.
4.	Set to Touch:	Not more than 24 hours at 72°F and 50% relative humidity.
5.	Curing Time:	Not more than 96 hours at 72°F and 50% relative humidity.
6.	Non-Volatile Content:	Not less than 92 percent.
7.	Hardness Rating (Durometer “Shore A”):	5-35.
8.	Resiliency:	Not less than 80 percent.
9.	Bond test methods shall be in accordance with WSDOT Test Method No. 412A.	

[1]Viscosity and application life may be waived providing the Material is mixed and placed by a pump and mixer approved by the Engineer, or if the Contract requires fast cure.

Suitable primer, if required by the manufacturer, shall be furnished with each joint sealer. The primer shall be suitable for brush or spray application at 50°F or higher and shall cure sufficiently at 50°F to pour the joint within 24 hours. It shall be considered as an integral part of the sealer system. Any failure of the sealer in the test described herein, attributable to the primer, shall be grounds for rejection of the sealer.

Acceptance of joint sealing compound for use on a project shall be on the basis of Laboratory tests of samples representative of each batch of Material to be used on the job. A period of at least two weeks shall be allowed for completion of these tests. Each container of the compound shall be clearly identified as to manufacturer and batch number.

9-04.2(3) POURED JOINT SEALER FOR WALKWAYS

Poured joint sealer used to seal sawed joints in sidewalks, stairs, plazas, and other walkways shall be a polyurethane sealer conforming to Federal Specification TT-S-00227E Type I (self-leveling) Class A or Type II (non-sag) Class A.

9-04.3 MORTAR AND NON-SHRINK CEMENT SAND GROUT

9-04.3(1) JOINT MORTAR

Mortar for hand mortared joints shall conform to Section 9-20.4(3) and consist of one part portland cement, three parts fine sand, and sufficient water to allow proper workability.

Cement shall conform to the requirements of AASHTO M 85, Type I or Type II.

Sand shall conform to the requirements of AASHTO M 45.

Water shall conform to the requirements of Section 9-25.1.

The mortar mix shall be approved by the Engineer before use.

9-04.3(2) NON-SHRINK CEMENT SAND GROUT

9-04.3(2)A GENERAL

Prior to placing the grout, the contact surface shall be thoroughly cleaned, roughened and wetted with water. The grout shall be covered with burlap sacks after the initial concrete set , promptly wetted, and maintained continuously moist until the required strength is obtained.

9-04.3(2)B GROUT FOR ANCHOR BOLTS, BRIDGE BEARINGS, AND DRAINAGE STRUCTURE

Non-shrink cement sand grout used for grouting anchor bolts and bridge bearings, curb section to pavement anchors, and for use in drainage Structures other than pipe connections, shall meet the requirements of section 9-20.3(2) grout type 2 for nonshrink applications.

9-04.3(2)C GROUT FOR PIPE CONNECTIONS AND POLES & PEDESTALS

Non-shrink cement sand grout for pipe connections to maintenance hole, catch basins, inlets, and similar utility appurtenances; installing tees; grouting under poles and pedestals; and similar uses shall meet the following requirements:

1. 1-part, by weight, Type III (H.E.S.) cement;
2. 2-parts, by weight, clean fine aggregate Class 1 or Class 2 (see Section 9-03.1(2)); and
3. Sufficient water complying with Section 9-25.1 to obtain a stiff consistency. The use of calcium chloride will not be allowed.

Unpolished aluminum powder shall be added to the dry cement in the proportion of one heaping teaspoonful per sack of cement no more than 30 minutes before the grout mixture reaches its final in-place position. The required compressive strength shall be a minimum 4,000 psi @ 7 Days.

9-04.3(2)D GROUT TYPE 1 FOR POST-TENSIONING APPLICATIONS

Grout type 1 for post-tensioning applications shall meet the requirements of Section 9-20.3

9-04.4 RUBBER GASKETS

9-04.4(1) RUBBER GASKETS FOR CONCRETE PIPES AND PRECAST MAINTENANCE HOLES

Rubber gaskets for use in joints of concrete Culvert or storm Sewer pipe and precast maintenance hole sections shall conform to the applicable requirements of ASTM C 443.

9-04.4(2) RESERVED

9-04.4(2)A SEALS FOR VITRIFIED CLAY PIPE (COMPRESSION)

Compression seals for vitrified clay pipe shall conform to the requirements of ASTM C 425. Each load of pipe delivered to the job site shall be accompanied by a certificate of compliance stating that the compression seals conform to the applicable provisions ASTM C 425 and showing test results of the lot from which the load of pipe was chosen.

Prior to shipment of pipe, the manufacturer shall submit shop drawings illustrating the proposed joint sealing system and results of testing required by ASTM C 425. The Engineer may require that testing be performed in his presence prior to acceptance of any joint sealing system. Pipe shall not be shipped without receiving the Engineer's approval of the jointing system.

9-04.4(2)B SEALS FOR VITRIFIED CLAY PIPE (FLEXIBLE COUPLINGS)

Flexible couplings shall meet the requirements of ASTM C 1173, Type B, including the requirements of Figure 2 and Table 3. Prior to use, a catalogue cut and manufacturer's certification stating that the flexible coupling conform to the requirements of this specification shall be submitted to the Engineer. This submittal shall be made separately for every size and configuration of coupling to be used.

9-04.4(3) RUBBER GASKETS FOR ALUMINUM OR STEEL CULVERT OR STORM SEWER PIPE

Gaskets for use with metal Culvert or storm Sewer pipe shall be continuous closed cell, synthetic expanded rubber gaskets conforming to the requirements of ASTM D 1056, Grade 2B3.

9-04.4(4) RUBBER GASKETS FOR ALUMINUM OR STEEL DRAIN PIPE

Gaskets for metal drain pipe shall be self-adhering, butyl-based scrim-supported type. When specified, the gaskets shall be as described in the Standard .

9-04.4(5) PROTECTION AND STORAGE

Rubber gasket Material shall be stored in a clean, cool place, protected from contaminants. They shall be protected from direct sunlight at all times except during actual installation. Pipes with gaskets affixed shall be installed in the line within 28 Days of date of delivery from the manufacturer. Rubber gaskets found on-site more than 28 Days after delivery from the manufacturer will be rejected. The Contractor shall submit an invoice from the manufacturer stating date of delivery.

9-04.5 FLEXIBLE PLASTIC GASKETS

The gasket Material shall be produced from blends of refined hydrocarbon resins and plasticizing materials reinforced with inert mineral filler and shall contain no solvents. It shall not depend on oxidizing, evaporating, or chemical action for adhesive or cohesive strength. It shall be supplied in extruded rope-form of such cross-section and size as to adequately fill spaces between the precast sections.

The gasket Material shall be protected by a suitable removable two piece wrapper so designed as to permit removing one half, longitudinally, without disturbing the other. Its composition and properties shall conform to those set forth as follows:

PROPERTY	TEST METHOD	MINIMUM	MAXIMUM
Bitumen (Petroleum plastic content)	ASTM D 4	50	70
Ash-inert Mineral Matter	AASHTO T 11	30	50
Penetration	ASTM D 217		
32°F (300gm) 60 sec		75	---
77°F (150gm) 5 sec		50	120
115°F (150gm) 5 sec		---	150
Softening Point	ASTM D 36	320°F	---
Specific Gravity at 77°F	ASTM D 71	1.20	1.35
Weight per gallon, lb.		10.0	11.3
Ductility at 77°F (cm)	ASTM D 113	5.0	---
Flash Point COC, °F	ASTM D 93	600	---
Fire Point COC, °F	ASTM D 92	625	---
Volatile Matter	ASTM D 6	---	2.0

9-04.6 EXPANDED POLYSTYRENE

Expanded polystyrene shall be of a cellular molded type with a density of 1.5 $\pm$ 0.25 pounds per cubic foot.

9-04.7 EXPANDED RUBBER

Closed cell expanded rubber joint filler shall conform to ASTM D 1056, Grade No. 2B3.

9-04.8 RESERVED

9-04.9 SOLVENT CEMENTS

Solvent Cements for PVC underdrain pipe shall conform to the requirements of ASTM D 2564.

9-04.10 CRACK SEALING - RUBBERIZED ASPHALT

Rubberized asphalt for crack sealing asphalt concrete pavement shall conform to AASHTO M 173 (ASTM D 1190) and have a COC flash point (AASHTO T 48) of 400°F minimum. AASHTO M 173 (ASTM D 1190) is modified to delete the Bond Test requirement. AASHTO T 48 is modified to require careful agitation of the rubberized asphalt sample during testing to prevent local overheating.

SECTION 9-05 STORM DRAIN AND SANITARY SEWER STRUCTURES, CULVERTS, AND CONDUITS

9-05.0 ACCEPTANCE BY MANUFACTURER'S CERTIFICATION

Certain drainage Materials may be accepted by the Engineer based on a Manufacturer's Certificate of Compliance meeting the requirements of Section 1-06.3. These Materials are as follows:

- Metal drain and underdrain pipe,
- PVC drain pipe and underdrain pipe,
- Polypropylene pipe
- Corrugated Polyethylene pipe
- Metal Culvert, Storm Drain pipe and pipe arch less than 30 inches in diameter,
- Metal Culvert end sections,
- Corrugated metal structural plate pipe, pipe arch, and under passes,
- Ductile iron pipe, Vitrified clay pipe compression seals, and

- Vitrified clay pipe flexible couplings

9-05.1 CONCRETE PIPE

9-05.1(1) GENERAL

Concrete pipe shall be manufactured by plants certified by the National Precast Concrete Association (NPCA). Concrete pipe shall meet the requirements of ASTM C 14 Class 3 for pipe less than 12 inches in diameter; ASTM C 76 Class IV for 12 and 15 inch diameter pipe; and ASTM C 76 Class III wall B for pipe 18 inches in diameter and larger. Exceptions may be specified in the Contract.

Pipe ends of reinforced concrete pipe shall be bell and spigot, modified bell and spigot, or tongue and groove unless otherwise specified in the Contract.

The identification of the minor axis of elliptical reinforcement shall be in accordance to Section 7-02.3(1)B4.

9-05.1(2) BASIS FOR ACCEPTANCE OF CONCRETE PIPE

9-05.1(2)A GENERAL

The basis for acceptance of non-reinforced concrete pipe shall be based on load bearing tests, material tests including absorption tests per ASTM C 497, inspection of the product at all stages of fabrication, and a Manufacturer's Certificate of Compliance indicating acceptable results of three edge bearing tests performed at the Supplier within the 90-Day period immediately preceding shipment of the pipe to the Project Site. Acceptance of the concrete pipe based on criteria other than these Specifications shall require a submittal to the Engineer for approval at least 10 Working Days in advance of delivery, specifying the "other criteria" in detail and how it is equivalent or better than the Specifications; a Manufacturer's Certificate of Compliance stating the pipe shall perform as specified in these Specifications; allow for the Engineer to visit the Supplier and observe the "other criteria", and shall allow the Engineer to have a minimum three (3) pipe samples provided to a location specified by the Engineer for the Engineer to conduct tests.

The basis for acceptance of reinforced concrete pipe 60 inches in diameter and smaller shall be determined by the results of the **three edge bearing test** per ASTM C 76 for the load to produce a 0.01 inch crack. Testing to the ultimate load will ordinarily not be required, except as necessary to obtain samples for making the absorption test. In lieu of broken pieces of pipe obtained as before mentioned, 4 inch diameter cores from pipe sections selected by the Engineer, shall be furnished to the Engineer for performing the absorption test. Sections of pipe which have been tested to the 0.01 inch crack limit will ordinarily not be further load tested; and such sections, if found without defect, meeting or exceeding the required Specifications will be accepted for use on the project.

Permeability test shall be conducted as follows:

The pipe selected by the Engineer for testing shall be placed plumb with either end down on a soft rubber impermeable pad and filled with water. The pipe shall be kept full of water for a period of 20 minutes. At the end of 20 minutes, the outer surface of the pipe will be examined for leaks.

A leak is herein defined as a moist spot as determined by the Engineer.

The Engineer may test up to 2 percent of all sections in a size and class of pipe; however, no less than 5 pipe sections of any pipe size and class will be tested.

Concrete pipe larger than 27 inch and no larger than 60 inch in diameter will be inspected by the Engineer during its manufacture and if found acceptable, the Engineer will issue a "Certification of Inspection". Pipe delivered for the Work shall be delivered with this "Certificate of Inspection". The Contractor shall notify the Engineer a minimum 15 Working Days prior to delivery to arrange for this inspection by the Engineer.

Acceptance of reinforced concrete pipe larger than 60 inch diameter will be based on inspection of the size and placement of the reinforcing steel, the absorption test and, at the option of the Engineer, on compressive strength tests of 4 inch diameter cores cut from the pipe, or on compressive strength of representative test cylinders cast with and cured with the pipe.

The Contractor shall provide a Manufacturer's Certificate of Compliance stating that the gaskets for all concrete pipe meet the requirements of ASTM C 443, and that the pipe age at shipment meets the requirements of Section 9-05.1(3). The Contractor shall also submit actual shop drawings detailing pipe reinforcement and joint design.

9-05.1(2)B PIPE ACCEPTANCE REPORT (PAR)

Concrete pipe with diameters of 27 inch and smaller shall be accompanied with a Pipe Acceptance Report when delivered to the Project Site. A PAR can be prepared either by WSDOT or by the SPU Materials Laboratory for a specific size and class of concrete pipe. Pipe delivered for incorporation into the Work shall meet all Contract requirements. Approval of the pipe upon delivery by the SPU Materials Laboratory does not constitute acceptance of the pipe at any time.

9-05.1(3) AGE AT SHIPMENT

Concrete pipe may be shipped when it complies with all specified test requirements. Unless it is tested and accepted at an earlier age, it shall not be considered acceptable and ready for delivery to the Work sooner than 28 Days after manufacture when made with Type II Portland cement, nor sooner than 7 Days after manufacture when made with Type III Portland cement.

9-05.1(4) RESERVED

9-05.1(5) BEVELED CONCRETE END SECTIONS

Beveled concrete end sections shall be plain concrete conforming to AASHTO M 86 or reinforced concrete conforming to the applicable sections of AASHTO M 170 with the design requirements as listed in Table 2, Wall B, Circular Reinforcement in circular pipe, and WSDOT Standard Plan no. B-70.20.

9-05.1(6) CONCRETE PIPE JOINTS AND TESTING

9-05.1(6)A GENERAL

All concrete pipe shall be joined with rubber gaskets. The joints and gasket material shall meet the requirements of ASTM C 443. Gasket Material shall be protected as specified in Section 9-04.4(5).

Both bell and spigot shall be reinforced in all pipe 30 inch or larger in diameter.

9-05.1(6)B TESTING CONCRETE PIPE JOINTS

9-05.1(6)B1 GENERAL

When a particular type of pipe joint design, joint Material, and/or joining method has not previously been tested and approved by the Engineer, the following tests shall be made on one test length of the assembled concrete pipe, or test length assembly as defined in Section 9-05.1(6)B2, to qualify the design, joint Material, and/or joining method for acceptance. As determined by the Engineer, additional testing may be required if subsequent field testing of installed pipe indicates difficulty in verifying acceptable joined pipe performance. The tests shall be conducted at the Supplier and the Contractor shall make available space and facilities to accommodate the testing in an efficient and workmanlike manner.

9-05.1(6)B2 HYDROSTATIC PRESSURE ON PIPES IN STRAIGHT ALIGNMENT

Hydrostatic pressure tests on pipes in straight alignment shall be made in accordance with the procedure outlined in paragraph 8(a) of AASHTO M 198, except that they shall be performed on a test length assembly consisting of not less than three nor more than five pipe sections selected from stock by the Engineer and assembled in accordance with Contract requirements. The end sections shall be bulkheaded and restrained to prevent leakage.

9-05.1(6)B3 HYDROSTATIC PRESSURE TESTS ON PIPES IN MAXIMUM DEFLECTED POSITION

Upon completion and acceptance by the Engineer of testing in accordance with Section 9-05.1(6)B2, the test length assembly shall be deflected until at least two of the pipe joints are deflected to the maximum as indicated in the manufacturer's installation instruction. When thus deflected, the test length assembly shall be braced and the end sections shall be bulkheaded and restrained to prevent leakage. The test length assembly shall then be pressurized to an internal hydrostatic pressure of 5 psig minimum, and no leakage at any joint for a 15 minute test duration will indicate acceptance by the Engineer.

9-05.1(6)B4 HYDROSTATIC PRESSURE TEST ON 15 INCH DIAMETER AND LARGER PIPE UNDER DIFFERENTIAL LOAD

For concrete pipe 15 inch or larger, upon completion and acceptance of testing in accordance with Section 9-05.1(6)B3, the test length assembly shall be suitably supported so that one of the pipes of the test assembly is suspended freely between adjacent pipes, be supported only by the joint connections. The suspended pipe shall then be loaded at its midpoint with an additional "point load" in accordance with the following schedule:

PIPE DIAMETER	LOAD
15 inches	7,400 lbs.
18 inches	8,800 lbs.
21 inches	10,000 lbs.
24 inches and larger	11,000 lbs.

"Point load" shall be interpreted as not more than two (2) linear feet spread over not more than one (1) linear foot beyond the midpoint of the pipe section supported.

While under this load, the test length assembly shall be braced and the end sections shall be bulkheaded and restrained to prevent leakage. The stressed joints, or joints at each end of the supported test section, shall show no leakage when subjected to an internal hydrostatic pressure of 5 psi for a 15 minute time duration. At the option of the Supplier or Contractor, 1/2 of the specified load may be applied on the bell end of the suspended pipe in lieu of the full load at the midpoint of the suspended pipe if the total half-load is applied over not more than an 18 inch length measured from the end of the pipe.

9-05.1(7) PERFORATED CONCRETE SUBSURFACE DRAIN PIPE

Perforated concrete subsurface drain pipe shall meet the requirements of AASHTO M 175, Type I, except that the perforations shall be approximately 1/2 inch in diameter. Strength requirements shall be as shown in Table I of AASHTO M 86.

9-05.2 DUCTILE IRON PIPE

Ductile iron pipe shall conform to ANSI A21.51 or AWWA C151 and shall be cement mortar lined, push-on joint, or mechanical joint. The ductile iron pipe shall be Class 50 unless indicated otherwise in the Contract.

Joints for ductile iron pipe shall be rubber gasketed conforming to the requirements of ANSI A21.11 or AWWA C111.

Cast iron fittings may be used with ductile iron pipe with Engineer's approval, and require the Contractor to submit a minimum of 10 Working Days in advance, the proposed fittings including a Manufacturer's Certificate of Compliance stating the fitting meets or exceeds the performance of the Material specified.

Saddles fastened to pipe with external bands will not be acceptable on any new ductile iron pipe installation (see Section 7-17.3(2)C3 item 3.). All fittings shall be the same material as the pipe being connected.

9-05.3 POLYVINYL CHLORIDE (PVC) PIPE

PVC pipe shall conform to the requirements of ASTM D 3034 for diameter sizes 4-inch through 15-inch, and of ASTM F 679 for diameter sizes 18-inch through 48-inch. The minimum pipe stiffness shall be 46 lb/in/in.

Joints for PVC pipe shall conform to ASTM D 3212 using an elastomeric gasket conforming to ASTM F 477.

Fittings for PVC pipe shall conform to ASTM D 3034, ASTM F 679, or ASTM F 1336. All fittings shall be the same material as the pipe being connected except that fittings using other materials or constructed with more than one material may be used subject to the approval of the Engineer. The Contractor shall submit at least 10 Working Days in advance, the proposed alternate material(s) and shall include a Manufacturer's Certificate of Compliance stating the alternate material meets or exceeds the handling and load stress performance of that specified.

9-05.3(1) PERFORATED PVC SUBSURFACE DRAIN PIPE

Perforated polyvinyl chloride sub-surface drain (SSD) pipe and fittings shall be ASTM D1785 Schedule 40 with rubber gasket joints. Pipe shall have slotted perforations 0.064 inches wide by 1.00 inch long and spaced 0.3 inch apart on center. The slotted perforations on the pipe shall be oriented as indicated in the Contract. Pipe size shall not exceed 8 inch diameter unless indicated otherwise in the Contract.

9-05.4 VITRIFIED CLAY PIPE (VCP)

Vitrified clay pipe shall conform to ASTM C 700, and all joints shall be factory manufactured in conformance with Section 9-04.4(2)A Vitrified clay pipe shall be installed as specified in Section 7-17.

Vitrified Clay Pipe shall be load tested in accordance with ASTM C301 for 3 edge bearing. Vitrified Clay Pipe shall withstand the minimum following loads:

MINIMUM TEST LOADS

EXTRA STRENGTH		HIGH STRENGTH	
NOMINAL SIZE (IN.)	LOAD (LBS./FT.)	NOMINAL SIZE (IN.)	LOAD (LBS./FT.)
4	2000	4	2200
6	2000	6	2200
8	2200	8	2400
10	2400	10	2600
12	2600	12	2900
15	3100	15	3400
18	3600	18	4000
21	4200	21	4600
24	4800	24	5300
27	5200	27	5700
30	5500	30	6100
33	5800	33	6400
36	6300	36	6900
39	6600	39	7300
42	7000	42	7700

9-05.4(1) PIPE ACCEPTANCE REPORT (PAR)

Vitrified clay pipe shall be inspected by the SPU Materials Laboratory at the point of delivery. When delivered, vitrified clay pipe shall be accompanied by all specified certifications and test results. No vitrified clay pipe shall be incorporated into the Work that has not been inspected and approved by the SPU Materials Laboratory. A pipe acceptance report will be completed by SPU Materials Laboratory personnel upon inspection of the pipe. Approval of pipe upon delivery by the SPU Materials Laboratory does not constitute acceptance of the pipe at any time.

9-05.5 POLYETHYLENE PIPE

9-05.5(1) CORRUGATED POLYETHYLENE DRAINAGE TUBING PIPE

9-05.5(1)A CORRUGATED POLYETHYLENE DRAINAGE TUBING DRAIN PIPE

Corrugated polyethylene drainage tubing drain pipe shall meet the requirements of AASHTO M 252. The maximum size pipe allowed shall not be larger than 10 inch diameter.

9-05.5(1)B PERFORATED CORRUGATED POLYETHYLENE DRAINAGE TUBING SUBSURFACE DRAIN PIPE

Perforated corrugated polyethylene drainage tubing subsurface drain pipe shall meet the requirements of AASHTO M 252 Type 5. The maximum size pipe shall be 10 inch in diameter.

9-05.5(2) CORRUGATED POLYETHYLENE DRAIN PIPE

9-05.5(2)A GENERAL

Corrugated polyethylene drain pipe shall be high density polyethylene (HDPE) meeting the requirements of AASHTO M 294, Type S. The size of pipe allowed shall range from a minimum 12 inch diameter through a maximum 48 inch diameter. All HDPE pipe delivered and used shall be certified through the Plastic Pipe Institute (PPI) Third Party Certification program and shall bear the Third Party Administered PPI seal.

9-05.5(2)B COUPLING BANDS

Joints for corrugated polyethylene drain pipe shall be made with a bell/bell or bell and spigot coupling using elastomeric gaskets conforming to ASTM F 477. Joints for Storm Drain pipe shall be made with a bell/bell or bell and spigot coupling and shall conform to ASTM D 3212 using elastomeric gaskets conforming to ASTM F 477. All gaskets shall be factory installed on the pipe in accordance with the Material Person's recommendations.

9-05.5(3) RESERVED

9-05.5(4) PERFORATED CORRUGATED POLYETHYLENE SUBSURFACE DRAIN PIPE

9-05.5(4)A GENERAL

Perforated corrugated polyethylene subsurface drain pipe shall be high density polyethylene (HDPE) meeting the requirements of AASHTO M 294, Type S. The size of pipe allowed shall range from a minimum 12 inch in diameter through a maximum of 48 inch diameter. Perforations shall be in accordance with AASHTO M 294. All HDPE pipe delivered and used shall be certified through the Plastic Pipe Institute (PPI) Third Party Certification program and shall bear the Third Party Administered PPI seal.

9-05.5(4)B COUPLING BANDS

Joints for perforated corrugated polyethylene subsurface drain pipe shall be made with a bell/bell or bell and spigot coupling using elastomeric gaskets conforming to ASTM F 477. All gaskets shall be factory installed on the coupling or on the pipe by the Material Person.

9-05.5(5) POLYETHYLENE END SECTIONS

High density polyethylene (HDPE) end sections shall be manufactured out of polyethylene resin complying with ASTM D 3350.

9-05.6 ALUMINUM PIPE

9-05.6(1) GENERAL

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

Corrugated aluminum drain pipe, aluminum culvert pipe, and aluminum pipe without perforations shall conform to the applicable requirements of AASHTO M 196.

The protective coating for aluminum pipe shall be Treatment 5 as specified in Section 7-02.3(1)C3a, and the pipe shall be constructed of helically corrugated lock seam aluminum pipe. An exception is allowed when gasketed helically corrugated lock seam aluminum pipe is specified in the Contract and Treatment 5 is not required.

Aluminum surfaces that are to be in contact with any Portland cement product (controlled density fill (CDF), concrete, grout, mortar, etc.) shall be protected by first cleaning the aluminum surface in contact with Portland cement product with solvent and then painting this surface with two coats of paint extending a minimum two feet beyond the area of contact with the Portland cement product. The paint shall conform to Federal Specification TT-P-645 (Primer, Paint, Zinc Chromate, Alkyd Vehicle).

9-05.6(1)A BASIS FOR ACCEPTANCE FOR ALUMINUM PIPE

The basis for acceptance of aluminum pipe will be the same as specified in Section 9-05.0, except when gasketed helically corrugated lock seam aluminum pipe is specified in the Contract. A qualification test, conducted by the Engineer, will be required of the Material Person for gasketed helically corrugated lock seam aluminum pipe, as the Engineer is required to identify specific pipe sizes and gasket materials that perform acceptably and reliably with confidence in specific applications.

9-05.6(1)B COUPLING BANDS

9-05.6(1)B1 COUPLING BANDS FOR DRAIN PIPE

Coupling bands for corrugated aluminum alloy drain pipe shall meet the requirements of coupling bands for Type I pipe of AASHTO M 196, except that bands using projections (dimples) will not be allowed. The bands shall be fabricated of the same material as the pipe.

Coupling bands for aluminum corrugated pipe shall be 24 inch, two-piece half-circle corrugated pipe held together with angles and bolts. A neoprene gasket shall be placed between the pipe and the bands. The bands shall be made of the same material and have the same corrugation as the pipe, and shall meet the requirements of Section 9-05.6(1)B2.

9-05.6(1)B2 COUPLING BANDS FOR CULVERT PIPE

Coupling for bands shall meet applicable requirements of AASHTO M 196. Bands having projections in lieu of corrugations will not be allowed.

Steel bolts and nuts for coupling bands shall meet the requirements of ASTM A 307 and shall be galvanized in accordance with AASHTO M 232 or AASHTO B 633.

Aluminum angles shall be of the same material as the coupling bands.

Rods, when required, shall meet the requirements of ASTM B 221, Alloy 6061-T6.

Asphalt coating shall not be used on coupling bands.

Coupling bands and aluminum pipe shall be the product of the same Material Person.

9-05.6(1)B3 COUPLING BANDS FOR ALUMINUM PIPE

Section 9-05.7(4)B shall apply to aluminum pipes, except the band shall have a range of thicknesses from not less than 0.60 inch to not larger than 0.105 inch.

Coupling bands and aluminum pipe shall be the product of the same Material Person.

9-05.6(1)C ELLIPTICAL FABRICATION

Section 9-05.7(2)B shall apply to aluminum culvert pipes.

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

9-05.6(1)D MITERED ENDS

Section 7-02.3(1)C2c shall apply to aluminum pipe.

9-05.6(1)E ASPHALT COATINGS

Asphalt coatings for aluminum Culvert pipe shall meet the requirements of Section 9-05.7(2)C.

9-05.6(1)F ALUMINUM END SECTIONS

The applicable provisions of AASHTO M 196 shall apply to the construction of end sections and toe plate extensions for aluminum pipes. In addition, they shall conform to the requirements of Section 9-05.7(2)G.

Asphalt coating shall not be used on aluminum end sections.

9-05.6(2) PERFORATED CORRUGATED ALUMINUM SUBSURFACE DRAIN PIPE

9-05.6(2)A GENERAL

Perforated corrugated aluminum subsurface drain pipe shall meet the requirements of AASHTO M 196, except that the perforations may be located at any location on the tangent of the corrugations providing the other perforation spacing meet Specifications.

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

9-05.6(2)B COUPLING BANDS

Coupling bands for corrugated aluminum subsurface drain pipe shall meet the requirements of coupling bands for Type III pipe of AASHTO M 196. The bands shall be fabricated of the same material as the pipe, if metallic bands are used.

Acceptable coupling bands are two-piece, helically-corrugated with nonreformed ends and integrally formed flanges; universal bands (dimple bands); a smooth sleeve-type coupler; and those bands meeting the requirements of Section 9-05.6(1)B2. Smooth sleeve-type couplers may be either plastic or aluminum, suitable for holding the pipe firmly in alignment without the use of sealing compound or gaskets.

9-05.6(3) ALUMINUM SPIRAL RIB PIPE

9-05.6(3)A GENERAL

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

Aluminum spiral rib pipe shall meet the requirements of AASHTO M 196 and these Specifications. The size, alloy, and protective treatment shall be as indicated in the Contract.

The Material Person of spiral rib pipe shall submit to the Engineer a Manufacturer's Certificate of Compliance stating that the Material furnished complies in all respects with these Specifications. The Engineer may require additional information or tests to be performed by the Contractor, at no expense to the Owner.

Unless indicated otherwise in the Contract, spiral rib pipe shall be furnished with pipe ends cut perpendicular to the longitudinal axis of the pipe. Pipe ends shall be cut evenly. Spiral rib pipe shall be fabricated by using a continuous helical lock seam with a seam gasket.

For spiral rib pipe, helical ribs shall project outwardly from the smooth pipe wall and shall be fabricated from a single uniform thickness material. The ribs shall be 3/4 inch wide by 3/4 inch deep with a nominal spacing of 7-1/2 inches center to center. Pipe shall be fabricated with ends that can be acceptably jointed with coupling bands.

For narrow pitch spiral rib pipe, helical ribs shall project outwardly from the smooth pipe wall and shall be fabricated from a single thickness of material. The ribs shall be 3/8 inch ± 1/8 inch wide (measured outside to outside) and a minimum of 0.4375 inch high (measured as the minimum vertical distance from the outside of pipe wall to top surface of the rib). The maximum spacing of ribs shall be 4.80 inch center to center (measured normal to the direction of the ribs). The radius of bend of the metal at the corners of the ribs shall be a minimum of 0.0625 inch with an allowable tolerance of plus or minus 10 percent.

For wide pitch spiral rib pipe, helical ribs shall project outwardly from the smooth pipe wall and shall be fabricated from a single thickness of material. The ribs shall be 3/4 inch ± 1/8 inch wide (measured outside to outside) and a minimum of 0.95 inch high (measured as the minimum vertical distance from the outside of pipe wall to top surface of the rib). The maximum spacing of ribs shall be 11.75 inches center to center (measured normal to the direction of the ribs). The radius of bend of the metal at the corners of the ribs shall be 0.0625 inch with an allowable tolerance of + 10 percent.

9-05.6(3)B CONTINUOUS LOCK SEAM PIPE

Pipes fabricated with continuous helical lock seam parallel to the rib may be used for full circle pipe. The lock seam shall be formed in the flat between ribs and shall conform to Section 13.2.1 through 13.2.5 of AASHTO M 196.

9-05.6(3)C BASIS FOR ACCEPTANCE FOR ALUMINUM SPIRAL RIB PIPE

The basis for acceptance will be a qualification test conducted by the Engineer for the Material Person of helically corrugated spiral rib, narrow pitch spiral rib or wide pitch spiral rib lock seam pipe, as the Engineer is required to identify specific pipe sizes and gasket materials that perform acceptably and reliably with confidence in specific applications.

Continuous lock seam pipe shall be sampled and tested in accordance with AASHTO T 249 and a Manufacturer's Certificate of Compliance stating the results shall be submitted to the Engineer.

9-05.6(3)D COUPLING BANDS

Coupling bands shall be of the same material as the pipe. Coupling bands and gaskets shall conform to Section 9-05.7(4)B.

9-05.6(4) ALUMINUM PIPE FOR DETENTION

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

Aluminum detention pipe shall be helical or annular corrugated aluminum pipe, meeting the requirements of AASHTO M 196, Type I with the gauge as indicated on the Drawings. The end plate and all end plate reinforcement shall be aluminum alloy 6061-T6 structural plate with the thickness as indicated on the Drawings.

Coupling bands for corrugated aluminum detention pipes shall be Type "D" per WSDOT Standard Plan no. B-60.40.

9-05.7 STEEL PIPE

9-05.7(1) GALVANIZED STEEL DRAIN PIPE

Galvanized steel pipe shall be 4 inch inside diameter, Schedule 40 pipe meeting the requirements of ASTM A 53.

9-05.7(2) STEEL CULVERT PIPE AND PIPE ARCH

9-05.7(2)A GENERAL

Steel Culvert pipe and pipe arch shall meet the requirements of AASHTO M 36, Type I and Type II. Welded seam aluminum coated (aluminized) corrugated steel pipe and pipe arch with metallized coating applied inside and out following welding is acceptable.

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

9-05.7(2)B ELLIPTICAL FABRICATION

When elongated pipes are specified, circular pipes shall be fabricated 5 percent out of round to form an elliptical section. The vertical or longer axis of the elliptical section shall be clearly marked before shipping.

9-05.7(2)C ASPHALT COATINGS AND PAVED INVERTS

Asphalt for asphalt coatings and paved inverts shall meet the requirements of AASHTO M 190, Section 4. The coatings for Treatments 1, 2, and 5 as specified in Section 7-02.3(1)C3a shall be uniform, inside and out, and applied as specified in the following.

The metal shall be free from grease, dirt, dust, moisture, or other deleterious contaminants. Either preheated or non-preheated process may be used as follows:

1. **Pipe Not Preheated**: The temperature of the asphalt at the time of pipe immersion shall be 400 °F (± 5 F°), and the duration of the immersion shall conform to the following schedule:

THICKNESS IN INCHES		MINIMUM IMMERSION TIME-MINUTES
STEEL	ALUMINUM	
.064	.060	2.5
.079	.075	3.0
.109	.105	5.0
.138	.135	6.5
.168	.164	8.0

2. **Pipe Preheated**: The asphalt shall have a temperature of 380 °F (± 5 F°), and the pipe shall be brought to a temperature of 300 °F to 350 °F before immersion.

Paved inverts for Treatments 2 and 4 as specified in Section 7-02.3(1)C3a shall consist of bituminous material applied in such a manner that one or more smooth pavements are formed in the invert filling the corrugations for at least 40 percent of the circumferential length. The pavement shall have a minimum thickness of 1/8 inch above the crest of the corrugations except where the upper edges intercept the corrugation. The pavement shall be applied following the coating with asphalt or fiber bonding.

Treatment 5 may be substituted for Treatment 2, and Treatment 6 for Treatment 4 at the option of the Contractor; however, the Contractor shall provide written notice to the Engineer of which treatment is used.

9-05.7(2)D SPUN ASPHALT LINING

Asphalt for spun linings over 100 percent periphery shall conform to AASHTO M 190, Section 4. Asphalt spun linings shall provide a smooth surface for the full interior of the pipe by completely filling the corrugations to a minimum thickness of 1/8 inch above the crests. The interior lining shall be applied by centrifugal or other methods resulting in the specified product. The interior shall be free from sags or runs, but slight residual corrugations due to cooling shrinkage of the lining will not be cause for rejection. At the three-sheet laps, an interior nonuniformity equal to the thickness of the sheet is allowable. The thickness of the lining shall be maintained to the ends of the pipe.

The thickness of the lining over the crest of the corrugation shall not vary by an amount in excess of 1/2 inch total over the entire area of the spun lining.

In the case of helical corrugated pipe manufactured with a continuous lock seam, an interior nonuniformity over the lock seam equal to the thickness of two culvert sheets is allowable.

9-05.7(2)E COUPLING BANDS

Coupling bands shall be flange bands or corrugated bands as shown on the Drawings, WSDOT Standard Plan no. B-60.40 Type D or as specified in the Contract, and shall be fabricated of the same material as the pipe and with the same metallic protective treatment as the pipe. The corrugated bands shall conform to the pipe and shall meet all applicable requirements of AASHTO M 36 except that coupling bands for all sizes of steel pipe arch with 3 inch x 1 inch corrugations shall be 24 inches wide. Bands having projections in lieu of corrugations will not be allowed.

Steel bolts and nuts for coupling bands shall meet the requirements of ASTM A 307 and shall be galvanized in accordance with ASTM A 153.

Steel angles, when required for coupling bands, shall meet the requirements of AASHTO M 36.

Asphalt coating shall not be used on coupling bands.

Coupling bands meeting the requirements of Section 9-05.7(4)B will also be acceptable.

Coupling bands and pipe shall be made by the same Material Person.

9-05.7(2)F STEEL CULVERT PIPE ARCH

Steel pipe arch shall meet the requirements for steel pipe and pipe arch of these Specifications except in the method of fabrication. Circular pipe shall be fabricated in two semi-circles, and the pipe arch shall be fabricated in two separate sections, the upper portion or arch, and the bottom section including the connecting arcs.

Both longitudinal edges of the lower section of the pipe arch shall be notched to provide interlocking seams which form the two segments into the full section when it is erected in the field. Hook and eye bolts, or other approved means, shall be provided to hold the segments firmly together.

Individual plates shall be a minimum of 2 feet in length except for short or half sections required to complete the end section of the Culvert.

When protective treatment is specified on the Drawings, pipe arch shall be coated with one of the treatments as provided in Section 7-02.3(1)C3a.

9-05.7(2)G STEEL END SECTIONS

9-05.7(2)G1 GENERAL

The applicable provisions of AASHTO M 36 shall apply to the construction of steel end sections, except that the end sections shall be fabricated of the same material with the same metallic protective treatment as the pipe.

Asphalt coating shall not be used on steel end sections.

9-05.7(2)G2 FABRICATION

The shape, thickness, dimensions, and number of pieces shall conform to WSDOT Standard Plan no. B-70.60 for the size and shape of pipe shown on the Drawings. They shall be manufactured as integral units or so formed that they can be readily assembled and erected in place. When bolts are used for assembly, they shall be 3/8 inch diameter or larger and shall be galvanized. No field welding or riveting will be permitted.

9-05.7(2)G3 GALVANIZED HARDWARE

Bolts, nuts, and miscellaneous hardware shall be galvanized in accordance with the provisions of AASHTO M 232.

9-05.7(2)G4 TOE PLATE EXTENSIONS

Toe plate extensions shall be furnished only when so specified in the Contract. When required, the toe plate extensions shall be punched with holes to match those in the lip of the skirt and fastened with 3/8 inch or larger galvanized nuts and bolts. Toe plate extensions shall be the same material and thickness as the end section and shall be fabricated of the same material with the same metallic protective treatment as the end section.

9-05.7(3) STEEL SPIRAL RIB DRAIN PIPE

9-05.7(3)A GENERAL

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

Steel spiral rib drain pipe shall meet the requirements of AASHTO M 36 and these Specifications. The size, coating, metal and protective treatment shall be as specified in the Contract.

The Material Person of spiral rib drain pipe shall furnish to the Engineer a Manufacturer's Certificate of Compliance stating that the Material furnished complies in all respects with these Specifications. The Engineer may require additional information or tests to be performed by the Contractor, at no expense to the Owner.

Unless otherwise specified in the Contract, spiral rib drain pipe shall be furnished with pipe ends cut perpendicular to the longitudinal axis of the pipe and shall be cut evenly. Spiral rib pipe shall be fabricated either by using a continuous helical lock seam with a seam gasket or a continuous helical welded seam paralleling the rib.

Spiral rib drain pipe shall have helical ribs that project outwardly, shall be formed from a single thickness of material, and shall conform to one of the following configurations:

1. AASHTO M 36, Section 7.2.2.
2. 0.375 inch, ±1/8 inch wide by 0.4375 inch (minimum) deep at 4.80 inch center to center.
3. 3/4 inch wide by 5/8 inch deep at 12 inch center to center.

Pipe shall be fabricated with ends that can be acceptably jointed with coupling bands.

When required, spiral rib pipe shall be bituminous treated or paved. The bituminous treatment for spiral rib pipe shall conform to the requirements of Sections 7-02.3(1)C3a and 9-05.7(2)C.

9-05.7(3)B CONTINUOUS LOCK SEAM PIPE

9-05.7(3)B1 GENERAL

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

Pipes fabricated with a continuous helical seam parallel to the rib may be used for full circle pipe. The lock seam shall be formed in the flat between ribs and shall conform to Sections 7.5.1 through 7.5.3 of AASHTO M 36.

For narrow pitch spiral rib pipe, the lap width specified in AASHTO M 36, Section 7.5.1 shall be 1/4 inch.

For use in applications without bituminous treatment, the continuous lockseam shall require prior acceptance by qualification testing conducted by the Engineer. The Contractor shall provide the Engineer at least 3 Working Days advance notice to arrange for this testing.

9-05.7(3)B2 BASIS FOR ACCEPTANCE

The basis for acceptance will be a qualification test conducted by the Engineer for each Material Person of helically corrugated, gasketed spiral rib, or narrow pitch spiral rib lock seam steel pipe as the Engineer is required to identify specific pipe sizes and gasket materials that perform acceptably and reliably with confidence in specific applications.

Continuous lock seam pipe shall be sampled and tested in accordance with AASHTO T 249 and a Manufacturer's Certificate of Compliance shall be submitted to the Engineer indicating compliance of the pipe with these Specifications.

9-05.7(3)C CONTINUOUS WELDED SEAM PIPE

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

Pipes fabricated with a continuous helical welded seam parallel to the ribs may be used for full circle pipe. The welding process for galvanized steel pipe shall be so controlled that the combined width of the weld and adjacent spelter coating burned by the welding does not exceed three times the thickness of the metal. If spelter is burned outside these limits, the weld and burned spelter shall be acceptably repaired for damaged galvanizing. Testing for welded seam quality control shall conform to AASHTO T 241. Welded pipe fabricated from aluminized steel pipe shall have the coating of the welded area repaired by flame-sprayed metallizing inside and out after welding.

Repair of Damaged Galvanizing: When the galvanized (zinc coated) surface has welding burn, all surfaces of the welded connections shall be thoroughly cleaned by wire brushing and all traces of the welding flux and loose or cracked galvanizing removed, after which the areas shall be repaired by flame spray metallizing both inside and out.

9-05.7(3)D COUPLING BANDS

Coupling bands shall be of the same material as the pipe. Coupling bands and gaskets shall conform to Section 9-05.7(4)B.

9-05.7(4) STEEL PIPE FOR SEWERS

9-05.7(4)A GENERAL

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

Steel pipe shall conform to the requirements of Section 9-05.7(2) for steel Culvert pipe, except that protective coating shall be Treatment 5 as specified in Section 7-02.3(1)C3a, and shall be constructed of either helically corrugated lock seam or helically corrugated continuous welded steel pipe. When gasketed helically corrugated lock seam steel pipe is called for, Treatment 5 is not required. Welded seam aluminum coated (aluminized) steel pipe shall require metallized aluminum coating inside and out following welding and shall not require Treatment 5.

9-05.7(4)B COUPLING BANDS

Coupling bands for steel pipe shall conform to the details shown in WSDOT Standard Plan no. B-60.40 Type D and to these Specifications, unless the Contract specifies otherwise.

Bands shall be made of the same base metal as the pipe. Band thickness shall not be thicker than 0.109 inch and may be two nominal thicknesses lighter than used for the pipe but in no case shall be not thinner than 0.64 inch. Corrugations on the bands shall be the same size and shape as those on the pipe to be connected. Steel bolts and nuts shall meet the requirements of ASTM A 307, and galvanized in accordance with AASHTO M 232. Welds shall develop the full strength of the parent metal.

Type F bands may be used as an alternate to all other band types shown for steel pipe sizes 12 inch to 84 inch diameter inclusive, provided that two annular corrugations are formed on each pipe end to be joined. The end corrugation shall be 2 inch x 1/2 inch and the inside adjacent corrugation shall be 2-2/3 inch x 1/2 inch.

When annular corrugated bands are used to connect lock-seam helically corrugated pipes, the seam shall be welded at the pipe ends prior to recorrugating to prevent unraveling of the seam.

Coupling bands and steel pipe shall be made by the same Material Person.

9-05.7(4)C BASIS FOR ACCEPTANCE

The basis for acceptance of steel pipe will be the same as specified in Section 9-05.0, except when gasketed helically corrugated lock seam steel pipe is called for. A qualification test conducted by the Materials Laboratory will be required for each manufacturer of gasketed helically corrugated lock seam steel pipe. Only those specific pipe sizes and gasket materials approved under the qualification test will be accepted.

9-05.7(5) STEEL PIPE FOR DETENTION

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

Steel detention pipe shall be galvanized helical or annular corrugated steel pipe, meeting the requirements of AASHTO M 36, Type 1, asphalt coated to requirements of AASHTO M 190, Type A with the gauge as indicated in the Contract. The end plate and all end plate reinforcement shall be structural steel plate of the type and thickness as designated in the Contract. Coupling bands for steel detention pipes shall be Type “D” per WSDOT Standard Plan no. B-60.40 unless the Contract specifies otherwise.

9-05.8 STRUCTURAL PLATES

9-05.8(1) STRUCTURAL PLATE PIPE, PIPE ARCH, ARCH, AND UNDERPASS

9-05.8(1)A GENERAL

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

Structural plate pipes shall be full circle of the type, gage or thickness, and diameter specified.

Structural plate pipe arches shall be a multi-centered shape, made up of four circular arcs tangent to each other at their junctions and symmetrical about the vertical axis, and of the type, gauge or thickness, and span specified in the Contract.

Structural plate arches shall be a single-centered circular arc shape placed on a reinforced concrete foundation, and of the design, type, gage or thickness, and span specified in the Contract.

Structural plate underpasses shall be a multi-centered shape, made up of a variable number of circular arcs tangent to each other at their junctions and symmetrical about the vertical axis, and of the design, type, gage or thickness, and span specified in the Contract.

9-05.8(1)B FABRICATION

The plates at longitudinal and circumferential seams shall be connected by bolts; the bolt holes shall be staggered in rows 2 inches apart, one hole being punched in the valley and one in the crest of each corrugation along both edges of each plate. Bolt holes on circumferential seams shall be spaced at approximate 12 inch intervals. No hole shall be closer to the edge of the plate than twice the diameter of the bolt.

The ends of structural plate pipes, pipe arches, arches, or underpasses shall not be mitered unless specified in the Contract. If mitered ends are specified, the slope shall conform to the slope of the embankment in which the Culvert is to be placed. The miter on pipe arches shall be limited to the top arc only.

9-05.8(1)C ELLIPTICAL FABRICATION

When elongated structural plate pipes are specified in the Contract, they shall be fabricated 5 percent out of round to form an elliptical cross section. The vertical axis (the longer axis of the elliptical section) shall be clearly marked on the plates before shipping.

9-05.8(1)D STRUCTURAL PLATE PIPE ARCH

Plates for structural plate pipe arches shall be formed so that the top shall be an arc of not more than 180 degrees nor less than 155 degrees; the bottom shall be an arc of not more than 50 degrees nor less than 10 degrees; and the top shall be joined at each end to the bottom by an arc having a radius between 18 and 31 inches and of not more than 87-1/2 degrees nor less than 75 degrees.

9-05.8(1)E STRUCTURAL PLATE ARCH

Structural plate arches and their foundations shall be as specified in the Contract.

9-05.8(1)F STRUCTURAL PLATE UNDERPASS

Structural plate underpasses shall be as specified in WSDOT Standard Plan nos. B-65.20 and B-65.40, or, unless a special design is specified in the Contract.

9-05.8(1)G CONCRETE FOR STRUCTURAL PLATE AND ARCH FOUNDATION

Concrete required for constructing structural plate arch foundations shall be Class 3000 concrete in conformance with the requirements of Section 6-02.3.

Steel reinforcing bars shall conform to the requirements of Section 9-07.

9-05.8(1)H PLATES

9-05.8(1)H1 CORRUGATED STEEL PLATES

Galvanized corrugated steel plates for constructing structural plate pipe, pipe arches, arches, and underpasses, and nuts and bolts used in their assembly shall conform to the requirements of AASHTO M 167 except that the minimum mass of spelter coating on the plates shall be 3 ounces of zinc per square foot of double exposed surface. The Engineer will find a lot unacceptable and will reject the lot if the average spelter coating as determined from any 3 samples of a lot is less than 3.0 ounce or if any one sample is less than 2.7 ounce. Nuts, bolts, and miscellaneous hardware shall be galvanized in accordance with AASHTO M 232.

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

9-05.8(1)H2 CORRUGATED ALUMINUM PLATES

Aluminum alloy plates and fasteners intended for use in the construction of structural plate pipe, pipe arches, arches, and underpasses shall conform to the requirements of AASHTO M 219. Nuts, bolts, and miscellaneous hardware shall be galvanized in accordance with AASHTO M 232.

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

9-05.9 PIPE COATINGS

9-05.9(1) ZINC COATED (GALVANIZED) OR ALUMINUM COATED (ALUMINIZED) CORRUGATED IRON OR STEEL DRAIN PIPE

9-05.9(1)A GENERAL

Zinc coated (galvanized) or aluminum coated (aluminized) corrugated iron or steel drain pipe shall meet the requirements of AASHTO M 36. The galvanized or aluminized sheet thickness shall be 0.052 inch for 6 inch diameter drain pipe, and 0.064 inch for 8 inch and larger diameter drain pipe. Welded seam aluminum coated (aluminized) corrugated iron or steel drain pipe with metallized coating applied both inside and outside after welding is acceptable.

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

9-05.9(1)B COUPLING BANDS

Coupling bands for zinc coated (galvanized) or aluminum coated (aluminized) corrugated iron or steel drain pipe shall meet the requirements of coupling bands for Type I pipe of AASHTO M 36, except that bands using projections (dimples) shall not be permitted. The bands shall be fabricated of the same material as the pipe, and with the same metallic protective treatment as the pipe.

Acceptable coupling bands for corrugated metal pipe shall be made using a 2-piece, 24 inch wide corrugated coupling band, held together with angles and bolts, a neoprene gasket between the pipe and the band, be of the same material and corrugations as the pipe, and meet the requirements of Section 9-05.7(2)E.

9-05.9(2) ZINC COATED (GALVANIZED) OR ALUMINUM COATED (ALUMINIZED) CORRUGATED IRON OR STEEL SUBSURFACE DRAIN PIPE

9-05.9(2)A GENERAL

Zinc coated (galvanized) or aluminum coated (aluminized) corrugated iron or steel subsurface drain pipe shall meet the requirements of AASHTO M 36, except that perforations required in Class I, Class II, and Class III pipe may be located anywhere on the tangent of the corrugations provided the other perforation spacing requirements meet Specifications. Welded

seam aluminum coated (aluminized) corrugated iron or steel subsurface drain pipe with metallized coating applied both inside and outside after welding is acceptable.

The pipe may conform to any one of the Type III pipes specified in AASHTO M 36, and perforations in Class I, Class II, and Class III pipe may be drilled or punched. The galvanized or aluminized sheet thickness shall be 0.052 inch for 6 inch diameter subsurface drain pipe, and 0.064 inch for 8 inch and larger diameter subsurface drain pipe.

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

9-05.9(2)B COUPLING BANDS

Coupling bands for zinc coated (galvanized) or aluminum coated (aluminized) corrugated iron or steel subsurface drain pipe shall meet the requirements of coupling bands for Type III pipe of AASHTO M 36. The bands shall be fabricated of the same material as the pipe and with the same metallic protective treatment as the pipe, if metallic bands are used.

Acceptable coupling bands are the two-piece, helically-corrugated band, with nonreformed ends and integrally formed flanges, universal bands (dimple bands), a smooth sleeve-type coupler, and those bands meeting the requirements of Section 9-05.7(2)E. Smooth sleeve-type couplers may be either plastic or steel suitable for holding the pipe firmly in alignment without the use of sealing compound or gaskets.

9-05.10 PLASTIC FOAM (ETHAFOAM)

Polyethylene plastic foam used in underground utility separation shall meet the Federal Specification Cid A-A 59136 Type 1, Class 1, Grade A (Ethafoam).

9-05.11 ABS COMPOSITE PIPE

ABS (acrylonitrile butadiene styrene) material shall not be used unless specified in the Contract or permitted by the Engineer.

ABS composite pipe shall meet the requirements of AASHTO M 264.

ABS composite pipe shall be provided with Type OR (flexible gasketed) joints. Rubber gasketed joints shall conform to applicable provisions of ASTM C 443.

Fittings for ABS composite pipe shall be specifically designed for connection to ABS composite pipe with solvent cement. Normally, all fittings shall be the same material as the pipe being connected, except that fittings using other materials or constructed with more than one material may be used subject to advance approval of the Engineer. Fittings shall have sufficient strength to withstand handling and load stresses encountered.

9-05.12 SAFETY BARS FOR CULVERT PIPE

Steel pipe used as safety bars and steel pipe used as sockets shall conform to the requirements of ASTM A 53, Grade B. Steel tubing used as safety bars shall conform to ASTM A 500, Grade B. Steel plate shall conform to ASTM A 36.

9-05.13 FLOW CONTROL STRUCTURE

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

The flow control Structure shall be made from a standard maintenance hole section as shown on Standard Plan no. 270 with diameter as indicated on the Drawings.

Where surface water is to enter directly through the cover of the flow control Structure, the frame and grate shall be as shown on Standard Plan no. 264, and the precast slab shall be as shown on Standard Plan nos. 243a and 243b with opening details to fit the diameter of the chamber. In all other cases, standard ring and cover (see Standard Plan no. 230) shall be used with a precast slab conforming to 200 Series Standard with a 24 inch round opening. Maintenance hole sections, castings and slabs shall meet the requirements of Section 7-05.

The flow control device and connection shall consist of a PVC pipe cross with an orifice, a pipe connection, and shear gate with a galvanized steel chain. The diameters of the control device and connection shall be the same as the diameter of the outlet pipe as indicated in the Contract. The PVC pipe used for the cross and connection shall comply with ASTM D 1785, Schedule 40. The PVC material used for the orifice plate and the shear gate shall be plate material in compliance with ASTM D 1784, PVC Class 12454-B. The orifice plate material shall be 1/4 inch thick and the shear gate material shall be 1/2 inch thick. The shear gate pin shall be of the same PVC material as the shear gate. The sheargate chain shall be 1/8” diameter Type 304 stainless steel straight link chain permanently attached to the Structure.

9-05.14 GALVANIZED IRON PIPE

Galvanized iron pipe 4 inch diameter and smaller shall be ASTM A 53 schedule 40 pipe.

9-05.15 CEMENT SLURRY - ABANDONING PIPE OR FILLING ANNULAR SPACE BETWEEN 2 PIPES

Cement slurry used to fill the annular space between an inner and outer pipe shall be pumpable, flowable, and shall completely fill the annular space. Materials shall have the following properties:

MATERIAL REFERENCE	MATERIAL PROPERTY
Cement, ASTM C 150	Type I / II
Slurry Density, ASTM C 138	65 pcf (minimum)
Foamed Slurry Density, ASTM C 138	45 pcf (minimum)
Water / Cement Ratio	0.90 (maximum)
Flow, ASTM C 939	18 seconds (maximum)
Shrinkage, ASTM C 827	non-shrink
Bleeding, ASTM C 232	no bleed
Set Time, ASTM C 403	3 - 6 hours[1]
COMPRESSIVE STRENGTH	
ASTM C 403 @ 24 hours	75 psi (minimum)
ASTM C 495 @ 7 Days	150 psi (minimum)
ASTM C 495 @ 28 Days	250 psi (minimum)

[1]Set time depends on temperature and site conditions.

9-05.16 SIDE SEWER AND SERVICE DRAIN

Sanitary side Sewer and service drain side Sewer Material shall be in accordance with the SMC Title 21 and other current Director's Rules, as applicable."[MWM1]

9-05.17 POLYPROPYLENE PIPE

Polypropylene Pipe, corrugated, single wall and double wall for diameter sizes 12 inch through 30 inch shall conform to the requirements of ASTM F2736. Third party certification that it meets ASTM F2764 shall accompany all delivered pipe.

Triple wall polypropylene pipe for diameter sizes 30 inch through 60 inch diameter shall conform to ASTM F2764. Third party certification that it meets ASTM F2764 shall accompany all delivered pipe.

SECTION 9-06 STRUCTURAL STEEL AND RELATED MATERIALS

9-06.1 STRUCTURAL CARBON STEEL

Structural carbon steel shall conform to the requirements of AASHTO M 270, Grade 36, Structural Steel For Bridges, unless the Contract specifies AASHTO M 183, Structural Steel.

9-06.2 STRUCTURAL LOW ALLOY STEEL

Structural low alloy steel shall conform to the requirements of AASHTO M 270, Grades 50 or 50W as specified in the Contract, unless the Contract specifies AASHTO M 223 or AASHTO M 222.

9-06.3 STRUCTURAL HIGH STRENGTH STEEL

Structural high strength steel shall be high yield strength, quenched and tempered structural steel conforming to the requirements of AASHTO M 270, Grades 70W, 100, or 100W as called out in the Contract, unless the Contract specifies AASHTO M 244.

9-06.4 RESERVED

9-06.5 BOLTS

9-06.5(1) UNFINISHED BOLTS

Unfinished bolts (ordinary machine bolts) shall conform to the specification requirements of ASTM A 307, Grade A or B. Nuts shall comply with ASTM A 563, Grade A requirements. Washers, unless otherwise specified in the Contract, shall meet ASTM F 844 specifications.

The Contractor shall submit a Manufacturer's Certificate of Compliance for the bolts, nuts, and washers prior to installing any of them.

9-06.5(2) RESERVED

9-06.5(3) HIGH STRENGTH BOLTS

High strength bolts for structural steel joints shall conform to the requirements of AASHTO M 164 or AASHTO M 253, Type 1, Type 2, or Type 3.

Bolts conforming to AASHTO M 164 that are galvanized in accordance with AASHTO M 232 shall be tested for embrittlement after galvanization. Test for embrittlement shall be in accordance with ASTM F 606, Section 7. Bolts conforming to AASHTO M 253 shall not be galvanized. AASHTO M 253 Type 1 and Type 2 bolts shall be painted with two coats of zinc rich paint, formula A-9-73, consisting of a minimum dry film thickness of 2 mils per coat.

Unpainted and nongalvanized bolts shall conform to AASHTO M 164 and AASHTO M 253, Type 3.

Nuts for high strength bolts shall meet the following requirements:

BOLT TYPE	REQUIREMENT
AASHTO M 164 BOLTS	
Black Type 1	AASHTO M 291 Grade C, C3, HD, DH3
AASHTO M 292 GRADE 2H	
Black weathering Type 3	AASHTO M 291 Grade C3 and DH3
Galvanized Type 1	AASHTO M 291 Grade DH AASHTO M 292 Grade 2H
AASHTO M 253 BOLTS	
Black Type 1 and 2	AASHTO M 291 Grade DH, DH3 AASHTO M 292 Grade 2H
Black weathering Type 3	AASHTO M 291 Grade DH3

Nuts that are to be galvanized shall be tapped oversized the minimum required for proper assembly. The amount of overtap shall be such that the nut assembles freely on the bolt in the coated condition and shall meet the mechanical requirements of AASHTO M 291 and the rotational capacity test specified in AASHTO M 164. The overtapping requirements of AASHTO M 291 Section 7.4 shall be considered maximum values.

Galvanized nuts shall be lubricated in accordance with AASHTO M 291 including supplementary requirement S2. Documentation shall include the name, method of application, and dilution of the lubricant applied to the nuts.

Washers for AASHTO M 164, Type 1 and Type 3 bolts, and AASHTO M 253, Type 1, Type 2, and Type 3 bolts shall meet the requirements of AASHTO M 293. The surface condition and weathering characteristics of the washers shall be the same as for the bolts being specified.

Direct Tension Indicators shall conform to the requirements of ASTM F 959 and may be used with either AASHTO M 164 or AASHTO M 253 bolts. Direct tension indicators shall be galvanized by mechanical deposition in accordance with AASHTO M 298, Class 55. Hot dip galvanizing will not be allowed.

All bolts, nuts, and direct tension indicators shall be marked and identified as required in the pertinent Specifications.

Lock-pin and collar fasteners which meet the materials, manufacturing, and chemical composition requirements of AASHTO M 164 or AASHTO M 253, and which meet the mechanical property requirements of the same specification in full size tests, and which have a body diameter and bearing areas under lock-pin head and collar not less than those provided by a bolt and nut of the same nominal size may be used. The Contractor shall submit a detailed installation procedure to the Engineer for approval. Should approval to use a lock-pin and collar fastener be given by the Engineer, it will be given prior to use on these types of fasteners.

The Contractor shall provide Manufacturer's Certificate of Compliance for all bolts, nuts, washers, and load indicators. The Manufacturer's Certificate of Compliance shall include certified mill test reports and test reports performed on the finished bolt confirming that all of the Materials provided meet the requirements of the applicable AASHTO or ASTM specification. See Section for testing and reporting requirements. The test report shall also include the date of testing, the lot identification of the bolts and nuts, and coating thickness for galvanized bolts and nuts. Shipping containers (not lids) shall be marked with the lot identification of the item contained therein.

Bolts shall be sampled prior to incorporating into a Structure. For the purposes of selecting samples, a lot of bolts shall be the quantity of bolts of the same nominal diameter and same nominal length in a consignment shipped to the Project Site. The minimum number of samples from each lot shall be as follows:

LOT SIZE	SAMPLE SIZE[1,2]
0 to 50	Note 3
51 to 150	4
151 to 1,200	6
1,201 to 10,000	10
10,001 to 35,000	16
35,001 and over	24

Notes 1. Bolts are galvanized, increase the sample size by 1.5 times the table value for the number of bolts being sampled.
2. Nuts, washers, and load indicator devices shall be sampled at the same frequency as the bolts.
3. Manufacturer's Certificate of Compliance required — samples not required.

All testing of bolts, nuts, washers, and load indicating devices shall be performed on specimens as they are to be installed.

All samples shall include a Manufacturer's Certificate of Compliance for each lot of bolts provided as defined in Section 1-06.3.

9-06.5(4) ANCHOR BOLTS

Anchor bolts shall meet the requirements of ASTM A 449. Galvanized anchor bolts shall be tested for embrittlement after galvanization in accordance with ASTM A 143. For galvanized anchor bolts with a length less than five times the nominal bolt diameter, the bolts shall be tested for embrittlement in accordance with ASTM F 606, Section 7.

Nuts for ASTM A 449 black anchor bolts shall conform to AASHTO M 291, Grade C. Nuts for ASTM A 449 galvanized bolts shall conform to AASHTO M 291, Grade DH and shall conform to the lubrication requirements of Section 9-06.5(3). Nuts for AASHTO M 164 black anchor bolts shall conform to AASHTO M 291, Grade C, C3, DH, and DH3 or AASHTO M 292, Grade 2H. Nuts for AASHTO M 164 galvanized anchor bolts shall conform to AASHTO M 291, Grade DH or AASHTO M 292, Grade 2H. Washers for ASTM A 449 anchor bolts shall conform to AASHTO M 293. Washers for AASHTO M 164 anchor bolts shall conform to ASTM F 436.

The bolts shall be tested by the manufacturer in accordance with the requirements of the pertinent specification and as specified in these Specifications. Anchor bolts, nuts, and washers shall be inspected prior to shipping to the Project Site. The Contractor shall submit to the Engineer for approval a Manufacturer's Certificate of Compliance for the anchor bolts, nuts, and washers, as defined in Section 1-06.3. If the Engineer deems it appropriate, the Contractor shall provide a sample of the anchor bolt, nut, and washer for testing.

All bolts, nuts, and washers shall be marked and identified as required in the pertinent specification.

9-06.6 RESERVED

9-06.7 RESERVED

9-06.8 STEEL CASTINGS

Steel castings shall conform to the requirements of AASHTO M 103, Mild to Medium Strength Carbon-Steel Castings for General Application, grade 70-36, unless otherwise designated in the Contract.

9-06.9 GRAY IRON CASTINGS

Gray iron castings shall conform to the requirements of AASHTO M 105. The class of castings to be furnished shall be as designated in the Contract.

9-06.10 MALLEABLE IRON CASTINGS

Malleable iron castings shall conform to the requirements of ASTM A 47.

9-06.11 STEEL FORGINGS AND STEEL SHAFTING

Steel forgings shall conform to the requirements of AASHTO M 102. The classes of forgings to be furnished shall be those specified in the Contract.

Steel shafting shall conform to the requirements of AASHTO M 169, Grade Designation 1016 to 1030 inclusive, unless otherwise specified in the Contract.

9-06.12 BRONZE CASTINGS

Bronze castings shall conform to the requirements of AASHTO M 107, Bronze Castings for Bridges and Turntables.

9-06.13 COPPER SEALS

Copper sheets for seals shall conform to the requirements of AASHTO M 138. They shall be UNS C12500, light cold rolled, and furnished in flat sheets each not less than 0.018 inch in thickness.

All splices or joints shall be carefully brazed or soldered to produce a continuous watertight seal for the full length of each unit.

9-06.14 DUCTILE IRON CASTINGS

Ductile iron castings shall conform to the requirements of ASTM A 536, Grade 80-55-06, unless otherwise specified in the Contract.

9-06.15 WELDED SHEAR CONNECTORS

Welded shear studs shall be made from cold drawn bar stock conforming to the requirements of AASHTO M 169, Grades 1010 through 1020, inclusive, either semi-killed or killed deoxidation.

The Material shall conform to the following mechanical properties:

Tensile Strength	60,000 psi min.
Yield Strength	50,000 psi min.
Elongation	20% min.
Reduction of Area	50% min.

Mechanical properties shall be determined in accordance with AASHTO Methods and Definitions T 244.

At the manufacturer's option, mechanical properties of the studs shall be determined by testing either the steel after cold finishing, or the full diameter finished studs.

9-06.16 ROADSIDE SIGN STRUCTURES

Materials in this Section apply to Division 6 Structures. See Section 9-28 for signing Materials and fabrication.

All bolts shall conform to AASHTO M 164. Washers for bolts shall be per AASHTO M 293.

Posts for single post sign structures shall meet the requirements of ASTM A 500, Grade B or ASTM A 53, Grade B.

Posts for multiple post sign structures shall meet the requirements of AASHTO M 183. Posts meeting the requirements of AASHTO M 222 or AASHTO M 223, Grade 50 may be used as an acceptable alternate to the AASHTO M 183 posts. All steel not otherwise specified shall conform to AASHTO M 183.

Triangular base stiffeners for one-directional multi-post sign posts shall meet the requirements of AASHTO M 222 or AASHTO M 223, Grade 50.

Base connectors for multiple directional steel breakaway posts shall conform to the following:

Bracket	Aluminum Alloy 6061 T-6
Bosses for Type 2B Brackets	ASTM A 582
Coupling Bolts	AASHTO M 164
Anchor Bolts	Type 304 stainless steel for threaded portion, AISI 1038 steel rod and AISI 1008 coil for cage portion.

Anchor couplings for multiple directional steel breakaway posts shall have a tensile breaking strength range as follows:

Type 2A	17,000 to 21,000 lb.
Type 2B	47,000 to 57,000 lb.

For multi-directional breakaway base connectors, shims shall be fabricated from pregalvanized sheet steel. For one-directional breakaway base connectors, single post or multi-post, shims shall be fabricated from brass conforming to ASTM B 36.

9-06.17 RESERVED

9-06.18 METAL BRIDGE RAILING

Metal bridge railing shall conform to the type and Material Specifications set forth in the Contract.

Section 8, part (b) of the Aluminum Association Standard Specifications for Aluminum Railing Posts Alloy A 344-T4 is hereby revised to provide that no X-ray inspection will be required after a foundry technique has been established for each mold which ensures production of castings that are free from harmful defects. Inspection for approval of castings will be made by the Engineer after the finished castings have been anodized as noted on the Drawings.

Welding of aluminum shall be in accordance with Section 6.9 of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, Fourth Edition-2001.

9-06.19 RESERVED

9-06.20 RESERVED

9-06.21 RESERVED

9-06.22 BOLTS, WASHERS, AND OTHER HARDWARE

Ordinary machine bolts and flat head bolts shall be made from commercial bolt stock meeting the specifications of ASTM A 307, and shall be grade A. Drift bolts and dowels may be either wrought iron or medium steel. Washers may be cast iron or malleable iron or may be cut from medium steel or wrought iron plate.

All bolts and other hardware which are to be galvanized and which require bending or shaping shall be hot forged to the required shape before galvanizing. Cold bending of such Material will not be permitted because of the tendency toward embrittlement during the galvanizing process. Galvanizing shall be in accordance with AASHTO M 232.

Split rings for log cribbing of 4 inches inside diameter shall be manufactured from hot rolled, low-carbon steel conforming to ASTM A 711 AISI, Grade 1015. Each ring shall form a true circle with the principle axis of the cross-section of the ring metal parallel to the geometric axis of the ring. The thickness of the metal section shall be 0.195 inch plus or minus 0.010 inch and the section shall be beveled from the central portion toward the edges to a thickness of 0.145 inch plus or minus 0.010 inch. It shall be cut through in one place in its circumference to form a tongue and slot. Split ring connectors shall be galvanized in accordance with AASHTO M 232.

Spike-grid timber connectors shall be manufactured according to ASTM A 47 for malleable iron castings. They shall consist of 4 rows of opposing spikes forming a 4-1/8 inch square grid with 16 teeth which are held in place by fillets which are diamond shaped in cross-section.

Nails shall be round wire of standard form. Spikes shall be wire spikes or boat spikes, as specified on the Drawings. Bolts, dowels, washers, and other hardware, including nails, shall be black or galvanized as specified on the Drawings, but if not so specified shall be galvanized when used in treated timber Structures.

SECTION 9-07 REINFORCING STEEL

9-07.1 GENERAL

Deformed steel bar shall be free from loose mill scale, dirt, grease, or other defects affecting the strength of bond with concrete. Deformed steel bar coated with rust shall be vigorously wire brushed clean. Size numbers shall be taken to represent the diameter of the bar in 1/8 inch units, except where standard wire gauge sizes are indicated in the Contract.

9-07.1(1) ACCEPTANCE BY MANUFACTURER'S CERTIFICATION

Reinforcing steel may be accepted by the Engineer based on the Manufacturer's Certificate of Compliance.

9-07.1(1)A ACCEPTANCE OF MATERIALS

Steel reinforcing bar manufacturers use either English or a Metric size designation while stamping rebar. The actual size of the bar, whether stamped with an English or a Metric size designation is acceptable. The Contract plans and the standard plans will continue to use an English size designation. The table below shows the comparable reinforcing steel bar size designations in the both units of measure:

ENGLISH DESIGNATION	BAR DIAMETER	METRIC DESIGNATION
#3	(0.375-inches)	#10
#4	(0.500-inches)	#13
#5	(0.625-inches)	#16
#6	(0.750-inches)	#19
#7	(0.875-inches)	#22
#8	(1.000-inches)	#25
#9	(1.128-inches)	#29
#10	(1.270-inches)	#32
#11	(1.410-inches)	#36
#14	(1.690-inches)	#43
#18	(2.260-inches)	#57

9-07.1(2) BENDING

Steel reinforcing bars shall be cut and bent by careful and competent workmen. They shall be bent cold to templates, which shall not vary appreciably from the shape and dimension shown on the drawings.

Hooks and bends of steel reinforcing bars shall be bent to the following inside diameters unless shown otherwise on the drawings:

BAR SIZE	STIRRUPS AND TIES	ALL OTHER BARS
No. 3	1-1/2 "	6 bar diameters
No. 4	2"	6 bar diameters
No. 5	2-1/2 "	6 bar diameters
No. 6	4-1/2 "	6 bar diameters
No. 7	5-1/4"	6 bar diameters
No. 8	6"	6 bar diameters
No. 9 through No. 11	---	8 bar diameters
No. 14 through No. 18	---	10 bar diameters

The supplementary requirements of AASHTO M 31 for bend tests shall apply to size No. 14 and No. 18 steel reinforcing bars which have hooks or bends.

Hooked ends of steel reinforcing bars shall be standard hooks unless shown otherwise in the Drawings. Standard hooks shall consist of a 90, 135, or 180-degree bend as shown in the Drawings plus a minimum bar extension at the free end of the bar shown in the table below. Seismic hooks shall consist of a 135-degree bend plus a minimum bar extension at the free end of the bar shown in the table below.

MINIMUM BAR EXTENSIONS FOR STANDARD AND SEISMIC HOOKS					
	180º HOOK	135º HOOK		90º HOOK	
BAR SIZE	ALL BARS	SEISMIC	ALL	STIRRUP	ALL
No. 3	2 ½″	3″	2¼″	2¼″	4½″
No. 4	2 ½″	3″	3″	3″	6″
No. 5	2 ½″	3¾″	3¾″	3¾″	7½″
No. 6	3″	4½″	4½″	9″	9″
No. 7	3½″	5¼″	5¼″	10½″	10½″
No. 8	4″	6″	6″	12″	12″
No. 9	4¾″				13¾″
No. 10	5¼″				15¼″
No. 11	5¾″				17″
No. 14	7″				20½″
No. 18	9¼″				27¼″

9-07.1(3) LENGTHS

Net lengths of bent bars shown in the “length” column of the bar list on the drawings are rounded to the nearest inch. Net length is the length of bar after all bend deductions are subtracted from the gross length.

9-07.2 DEFORMED STEEL BARS

Deformed steel bars for concrete reinforcement shall conform to either AASHTO M 31 Grade 60, or ASTM A 706, except as otherwise noted. Steel reinforcing bar for the cast-in-place components of bridge structures (excluding sidewalks and barriers but including shafts and concrete piles), and for precast substructure components of bridge structures, shall conform to ASTM A 706 only. However, in computing the ultimate unit tensile stress from test data, the area may be corrected for mass per linear foot of the bar within the weight tolerances listed. No such correction for mass shall be used in calculating the yield stress; the nominal area of the bar, as given in Table 1 of AASHTO M 31 or ASTM A 706, shall be used in this computation.

Deformed steel bars are referred to in the Plans and Specifications by number: for example, No. 3, No. 4, No. 5, etc.

9-07.3 EPOXY-COATED STEEL REINFORCING BARS

Epoxy-coated rebar shall be coated according to AASHTO M 284 with the additional following modifications:

1. The list of steel reinforcing bars acceptable for coating shall include ASTM A 706.
2. The Contractor shall furnish a written certification that properly identifies the material, the number of each batch of coating material used, quantity represented, date of manufacture, name and address of manufacturer, and a statement that the supplied coating material meets the requirements of AASHTO M 284.
3. The Contractor shall supply to the Engineer an 8 ounce representative sample of the coating material from each batch of coating material. The sample shall be packaged in an airtight container and identified as epoxy coating material by batch number.
4. Prior to coating the bars, the Contractor shall submit to the Engineer for review, the coating material manufacturer’s recommendation on the proper use and application requirements of the coating material.
5. A Manufacturer's Certificate of Compliance stating that all bars have been coated in accordance with the coating material manufacturer’s recommendations and these Specifications shall be furnished with each shipment. This certification shall include for each bar size the preheat temperatures, cure times, thickness checks, holidays detected, and test results.
6. The Contractor shall give advance notice to the Engineer of the coating schedule at the coating plant so that Engineer inspection for approval may be provided.
7. The patching material, compatible with the coating material and inert in concrete, shall be supplied with each shipment.
8. For projects where epoxy-coated steel reinforcing bars are used in the top mat of bridge decks only, the maximum amount of damage to the coating shall not exceed 0.25 percent of the surface area of each bar.
9. The thickness of epoxy-coating shall be 10 mils ± 2 mils.

10. All samples shall be submitted to the SPU Materials Laboratory (see Section 1-05.3(1) C).

9-07.4 PLAIN STEEL BARS

Where plain steel bars are specified, they shall conform to the chemical and physical properties of AASHTO M 31, Grade 60, unless specifically noted otherwise. Plain steel bars are indicated in the Contract by fractions of an inch; for example, 3/8 inch Ø, 1/2 inch Ø, 5/8 inch Ø, etc.

9-07.5 DOWEL BARS (FOR CEMENT CONCRETE PAVEMENT)

Epoxy coated dowel bars shall be round plain steel bars of the dimensions shown in the Standard Plans. They shall conform to AASHTO M 31, Grade 60 or AASHTO M 255, Grade 60 and shall be coated in accordance with ASTM A 934. The thickness of the epoxy coating shall be 10 mils plus or minus 2 mils. In addition, the requirements of Section 9-07.3, Items 2, 3, 4, 5, 6, 7, and 10 shall apply.

9-07.6 TIE BARS (FOR CEMENT CONCRETE PAVEMENT)

Tie bars shall conform to the requirements of the Standard Specifications for Deformed Billet-Steel Bars for Concrete Reinforcement, AASHTO M 31, Grade 40 and shall be coated in accordance with AASHTO M 284. Deformed bar shall be 5/8 inch diameter and 30 inch long.

The form of the deformed bar shall be subject to approval by the Engineer.

Tie bars shall be free from dirt, grease, or other defects affecting the strength or bond with the concrete. Tie bars shall be epoxy encapsulated.

9-07.7 WIRE MESH

Wire mesh for concrete reinforcement shall conform to the requirements of AASHTO M 55, Welded Steel Wire Fabric for Concrete Reinforcement or AASHTO M 221, Welded Deformed Steel Wire Fabric for Concrete Reinforcement. All wire mesh shall be of an approved kind and quality of manufacture.

9-07.8 DEFORMED WIRE

Deformed wire shall conform to the requirements of AASHTO M 225, Deformed Steel Wire for Concrete Reinforcement.

Deformed wire is noted in the Contract by the letter D, followed by a number indicating the cross-sectional area of the wire; for example, D2, D5, D20, etc.

9-07.9 COLD DRAWN WIRE

Cold drawn wire shall conform to the requirements of AASHTO M 32, Cold Drawn Steel Wire for Concrete Reinforcement.

Cold drawn wire is noted in the Contract by the letter W followed by a number indicating the cross-sectional area of the wire; for example, W2, W5, W20, etc.

9-07.10 PRESTRESSING REINFORCEMENT

Prestressing reinforcement shall be ½-inch diameter for precast-prestressed concrete piles and ½-inch or 0.6-inch diameter for pretensioned concrete girders, post-tensioned segmental precast concrete girders, or cast-in-place prestressed concrete.

Prestressing reinforcement shall be mill bright high tensile strength seven wire low relaxation strand conforming to the requirements of AASHTO M 203, Grade 270.

All prestressing reinforcement furnished for a given structural member shall have a maximum elongation differential of 3 percent at stress of 0.8 of the ultimate strength of the prestressing steel. Each reel of prestressing reinforcement shall be accompanied by a Manufacturer's Certificate of Compliance, a mill certificate, and a test report. The mill certificate and test report shall include the yield and ultimate strengths, elongation at rupture, modulus of elasticity, and the stress strain curve for the actual prestress reinforcing intended for use. All values certified shall be based on test values and actual sectional areas of the material being certified.

For every five reels furnished, one sample, not less than 5½-feet long, shall be sent to the SPU materials lab for testing; see Section 1-05.3. Samples of the furnished reels with Manufacturer's Certificate of Compliance, a mill certificate, and test report may be shipped directly by the manufacturer to the Engineer. An independent inspector, approved by the Owner, shall be present during sampling and shall provide a written certification to the Engineer.

9-07.10 PRESTRESSING REINFORCEMENT BAR

High-strength steel bars shall conform to AASHTO M 275, Type II.

Nuts shall conform to either ASTM A 29 Grade C1045, or ASTM A 536 Grade 100-70-03, and shall be capable of developing the larger of either 100 percent of the minimum ultimate tensile strength (MUTS), or 95 percent of the actual ultimate tensile strength (AUTS), of the bar. The anchor nuts shall conform to the specified strength requirement while permitting a maximum 5 degree misalignment between the nut and the bearing plate. A minimum of three tests, each from a different heat, are required.

Couplers, if required, shall be AASHTO M 169 Grade 1144, or equivalent steel, developing the larger of either 100 percent of the MUTS, or 95 percent of the AUTS, of the bar. The test shall be performed with the coupler having a one inch unengaged segment between the two coupled bars. A minimum of three tests, each from a different heat, are required.

For unbonded bars under dynamic loading, the connections shall withstand at least 500,000 cycles from 60 percent to 66 percent MUTS followed by at least 50 cycles between 40 percent MUTS and 80 percent MUTS. A minimum of three tests, each from a different heat, are required.

SECTION 9-08 PAINTS

9-08.1 RAW MATERIALS

The acceptance of particular lots of raw materials shall in no way obligate the Engineer to accept lots of finished paint that do not conform to the requirements of these Specifications. When not specifically detailed, the raw Materials shall meet the requirements of the applicable Federal and State Paint Specifications, Department of Defense (DOD), American Society on Testing of Materials (ASTM), and Steel Structures Painting Council (SSPC) specifications for said material. Raw Materials for paints shall conform to the requirements of the Specifications as follows:

Alkyd resin solution, Federal TT-R-266D.

Aluminum paste, ASTM D 962, Type II, Class B. Paints made with the paste shall be smooth and highly lustrous.

Anti-skinning agent shall have no deleterious effect on the drying time of the finished paint. It shall effectively prevent skinning when added in the amounts specified in each formula and tested in accordance with Federal Test Std. No. 141a, Method 3021.

Aromatic petroleum thinner - water white low aniline petroleum solvent Kauri-Butanol value 70 (min.).

Barium sulfate pigment, ASTM D 602.

Chrome oxide green, ASTM D 263. The tinting properties shall be such that the standard color of the formulas using chrome oxide green can be produced without departing from the limits of composition given in those formulas.

Chrome yellow pigment and paste, ASTM D 211, Type III.

Fibrous magnesium silicate (talc), or Magnesium Silicate Pigment, ASTM D 605.

Lampblack pigment and paste, ASTM D 209.

Liquid drier, ASTM D 600.

Mineral spirits, ASTM D 235.

Raw linseed oil, ASTM D 234.

Red iron oxide pigment, ASTM D 3721, ASTM D 3722 & ASTM D 3724.

Silica shall be finely ground amorphous or crystalline materiaI. It shall have a maximum oil absorption of 50 when tested in accordance with ASTM D 281.

Soya lecithin shall be pure.

Spar varnish, Federal TT-V-119.

Titanium pigments, ASTM D 476. Titanium dioxide for use in exterior white paints shall conform to Type II. Titanium pigments used in tinted paints and enamels shall be exterior chalk resistant, Type III.

Turpentine shall be gum spirits of turpentine, ASTM D 13.

Yellow iron oxide, hydrated, ASTM D 768.

Zinc oxide pigment and paste, ASTM D 79.

Zinc yellow (zinc chromate), ASTM D 478.

Raw materials and paints not specifically covered (or specifications or out dated) shall meet current Federal and State Paint Specifications, Department of Defense (DOD), American Society on Testing of Materials (ASTM), and Steel Structures Painting Council (SSPC) specifications for said material. The colors, where designated, shall conform to Section 9-08.8.

9-08.2 PAINT FORMULAS - GENERAL

All paints shall be made from materials meeting the requirements specified in Section 9-08.1. The paint shall be made in accordance with the following formulas and shall meet the requirements set forth above as well as the special requirements set forth for each formula. The formulas are stated in terms of dry pigment. Each formula shall contain the specified raw materials which shall be proportioned to give the compositions in percentages by weight or parts by weight, as shown in the formulas that follow.

1. **Formula A-5-61 - Vinyl Pretreatment**:

The primer shall meet the requirements of Federal Specification DOD-P-15328B or DOD-P-15328C, Primer Pretreatment (Formula 117B for Metals).

Vinyl Wash Primer shall be mixed by adding 1 volume of acid component (diluent) to 4 volumes of resin component (base solution) slowly and with constant stirring. The material shall be used within 8 hours of mixing. The wash primer coat shall be spray applied to all surfaces at a coverage rate of 250 to 300 square feet per gallon to yield a dry film of 0.5 to 0.9 mils thickness. If necessary to maintain a wet spray, additional thinning with normal Butanol or 99 percent Isopropanol will be allowed. Acid component above the required amount shall not be used for thinning. A drying time of 1 hour is required before recoating.

a. Butanol shall meet Federal Specification TT-B-846b Butyl Alcohol; Normal.
b. Isopropanol (99 percent) shall conform to ASTM D 770 Isopropyl Alcohol.

2. **Formula A-6-86 - Zinc Dust Zinc Oxide Primer:**

The primer shall meet the requirements of Federal Specification TT-P-641G primer, coating, zinc dust-zinc oxide (for galvanized surfaces).

3. **Formula A-9-73 - Galvanizing Repair Paint, High Zinc Dust Content**:

The galvanizing repair paint shall meet the requirements of Federal Specification MIL-P-21035B (Ships) Paint, High Zinc Dust Content, Galvanizing Repair.

4. **Formula C-6-90 - Green Phenolic Finish Coat for Steel**:

Zinc chromate (dry pigment)	13.8 parts
Chrome green oxide (dry pigment)	16.1 parts
Titanium dioxide (dry pigment)	16.7 parts
Yellow iron oxide (dry pigment)	1.3 parts
Fibrous magnesium silicate (dry pigment)	5.0 parts
Aluminum stearate (dry pigment)	0.2 parts
Spar varnish	22.1 parts
Raw linseed oil	21.4 parts
Driers	1.0 parts
Anti-skinning agent	0.1 parts
Mineral spirits	2.3 parts
Weight per gallon (minimum)	12.5 pound
Viscosity at 70°F	80 $\pm$ 8 K.U.
Grind (Minimum)	6
Set to touch	4 hours
Dry hard	18 hours
Sag Index	7 min.
Test Requirements	Prior to shipment
Viscosity Adjustment	Mineral spirits to be added at the factory to achieve the specified viscosity

The proportions of tinting pigments may be varied to achieve the desired color. The color of the paint when dry shall match the color of a standard C-6-90 color chip. Additional tinting pigments may be required.

5. **Formula C-9-90 - Phenolic Finish Coat for Steel**:

Zinc Oxide (dry pigment)	10.0 parts
Titanium Dioxide (dry pigment)	21.0 parts
Fibrous Magnesium Silicate (dry pigment)	3.2 parts
Barium Sulfate (dry pigment)	12.8 parts
Tinting Pigments	5.9 parts
Treated Bentonite Clay (dry pigment)	0.2 parts
Anti-Sag Agent	1.9 parts
Raw Linseed Oil	12.6 parts
Spar Varnish	29.0 parts
Anti-Skin Agent	0.1 parts
Driers	1.0 parts
Mineral Spirits	1.8 parts
Xylene	0.5 parts
Weight per gallon (minimum)	12.3 lbs.
Viscosity	80 $\pm$ 8 K.U.
Dry Hard (maximum)	18 hours
Set to Touch (maximum)	4 hours
Grind (N.S.) (minimum)	5
Sag Index (minimum)	4
Total Solids by Weight	80 $\pm$ 5%
Test Requirements	Prior to shipment

Adjustments for tinting pigments and talc, solvents and chemical additives shall be made at the factory to achieve the desired color and physical characteristics. A fungicide, N-(Trichloromethylthio) phthalimide shall be added at the rate of 3 pounds per 100 gallons.

6. **Formula C-10-83 - Vinyl Finish Coat**:

Vinyl Finish Coat shall conform to the following Specifications:

a. **Pigment (12 Percent Minimum by Weight)** - A combination of titanium dioxide and colored pigments or a combination of colored pigments such that the resultant paint when dry matches the color sample available at the SPU Materials Laboratory or Federal Color Code 595 as specified.

b. **Vehicle (88 Percent Maximum by Weight)**.

Vinyl Resin Type II[1]	9.1 parts
Vinyl Resin Type III[2]	9.1 parts
Tricresyl Phosphate	3.4 parts
Methyl Isobutyl Ketone	39.2 parts
Toluene	39.2 parts
Total	100.0

[1]Vinyl Resin Type II shall be hydroxyl containing vinyl chloride-acetate copolymer. It shall contain 89.5 to 91.5 percent (by weight) vinyl chloride, 2.0 to 5.5 percent vinyl acetate and 5.3 to 7.0 percent vinyl alcohol. It shall produce results in the specified formulations equal to the Bakelite Corporation Vinylite resin VAGH.

[2]Vinyl Resin Type III shall be a vinyl chloride-acetate co-polymer of medium average molecular weight and shall contain 85 to 88 percent vinyl chloride and 12 to 15 percent vinyl acetate by weight. It shall produce in the specified formulations results equal to Bakelite Corporation Vinylite resin VYHH.

Lampblack shall be ground in the Vinyl Finish Coat vehicle to yield a smooth well ground paint, Black Vinyl Tinting Paste, acceptable for tinting the Vinyl Finish Coat.

The Vinyl Finish Coat and Vinyl Tinting Paste shall be ground to a fineness of not less than 5 when testing in accordance with ASTM D1210.

Vinyl Thinner shall be composed of the following Materials:

Toluene	90 percent by volume
Methyl Isobutyl Ketone	10 percent by volume

The paints as received require thinning with from 20 to 35 percent by volume of Vinyl Thinner to maintain a wet spray.

7. **Formula D-1-57 - Aluminum Paint**:

Aluminum paste Type 2 Class B	2.0 pounds
Spar Varnish	1.0 gallon

Aluminum paint shall be mixed on the Job Site, and only enough for one Day shall be mixed at a time. The weighed amount of paste shall be placed in a suitable mixing container and the measured volume of vehicle then poured over it. The paste shall be incorporated by vigorous stirring with a paddle.

Test Requirements: Prior to mixing.

8. **Formula D-4-57 - Black Enamel**:

The enamel shall meet the requirements of Federal TT-E-529 Black Enamel, Synthetic, Semi Gloss.

Test requirements: This enamel will be sampled and tested in the ready-mixed form.

9. **Formula D-5-83 - White Guard Rail Paint (Alkyd Vehicle)**:

Titanium dioxide (dry pigment)	28.1 parts
Zinc oxide (dry pigment)	10.9 parts
Fibrous magnesium silicate (dry pigment)	4.3 parts
Aluminum stearate (dry pigment)	0.5 parts
Alkyd vehicle	37.0 parts
24% lead naphthenate drier	0.4 parts
6% Cobalt naphthenate drier	0.2 parts
6% Manganese naphthenate drier	0.2 parts
Anti-skinning agent	0.2 parts
Mineral spirits	18.2 parts
Weight per gallon (minimum)	11.0 pound
Viscosity at 70°F.	80-90 K.U.
Nonvolatile content (minimum)	70.2%
Grind (minimum)	4
Hiding power (maximum scale reading)	30
Set to touch	4 hours
Dry hard	18 hours
Sag Index	7 min.
Test Requirements	Prior to shipment
Viscosity Adjustment	Mineral spirits shall be added at the factory to achieve the specified viscosity

This formula is to be used over primed or previously painted surfaces.

10. **Formula E-1-57 - White for Wood Structures**:

The Material shall conform to Federal TT-P-102, Class A.

Test Requirements: This paint will be sampled and tested in the ready-mixed form.

Primer: Turpentine may be added to the above paint in quantities not to exceed 1-1/2 pints per gallon of paint for use as a primer.

11. **Formula E-2-62 - Primer for Wood**:

The primer shall be a ready mixed priming paint for use over unpainted wood surfaces. It shall meet the requirements of Federal Specification TT-P-25 Primer, Paint, Exterior.

Test Requirements: This paint shall be sampled and tested in the ready mixed form.

12. **Formula F-3-64 - Orange Equipment Enamel**:

The enamel shall meet the requirements for Enamel, Alkyd, Gloss, Federal Specification TT-E-489, except that the Sag Index shall be seven minimum. The color, when dry, shall match that of Federal Standard No. 595, color 12246.

Test Requirements: When manufactured on Contract or Purchase Order for maintenance use, the enamel will be sampled and tested in the ready-mix form. No factory inspection will be required; however, a one pint sample representing the batch shall be submitted to the SPU Materials Laboratory for approval before use.

For factory application to individual items of new equipment, samples of the enamel will not be required; however, the equipment manufacturer shall match the color and certify the quality of enamel used.

13. **Formula H-1-83 - Primer for Concrete**:

Titanium dioxide	5.0 parts
Calcium carbonate	19.7 parts
Fibrous magnesium silicate	6.8 parts
Silica	6.8 parts
Spar varnish	52.3 parts
Mineral spirits	9.4 parts
Weight per gallon (minimum)	9.8 pounds
Drying time (for testing purposes only)	18 hours
Viscosity at 70° F	65-75 K.U.
Consistency:	The paint shall not thicken after manufacture to an extent sufficient to impair its brushing qualities.
Test Requirements:	Prior to shipment

14. **Formula H-2-83 - White Masonry Paint for Precast Curbs**

Titanium dioxide (dry pigment)	11.9 parts
Calcium carbonate (dry pigment)	25.6 parts
Mica (dry pigment)	7.4 parts
Diatomaceous silica (dry pigment)	7.0 parts
Bentone (body agent)	0.5 parts
Pliolite S5-A	8.0 parts
Chlorinated Paraffin 40%	4.0 parts
Chlorinated Paraffin 70%	4.0 parts
Aromatic brushing thinner	31.6 parts
Viscosity at 70°F	90-100 K.U.
Weight per gallon (minimum)	12.1 pounds
Drying time (for test purposes only)	18 hours
Test requirements	Prior to shipment

15. **Formula H-3-83 - Yellow Masonry Paint for Precast Curbs**

Titanium dioxide (dry pigment)	1.0 parts
Medium chrome yellow (dry pigment)	10.9 parts
Calcium carbonate (dry pigment)	25.6 parts
Mica (dry pigment)	7.4 parts
Diatomaceous silica (dry pigment)	7.0 parts
Bentone (body agent)	0.5 parts
Pliolite S5-A	8.0 parts
Chlorinated paraffin 40%	4.0 parts
Chlorinated paraffin 70%	4.0 parts
Aromatic brushing thinner	31.6 parts
Viscosity at 70°F	90-100 K.U.
Weight per gallon (minimum)	12.1 pounds
Drying time (for test purposes only)	18 hours
Test requirements	Prior to shipment

16. **Formula K-1-83 - Exterior Acrylic Latex Paint-White**:

This paint shall meet the requirements of Federal Specification TT-P-19, Paint, Acrylic Emulsion, Exterior, except that the viscosity shall be 75-85 K.U.

This paint may be used self-primed in multiple coats over salts treated wood and on interior and exterior masonry surfaces.

Test Requirements: This paint will be sampled and tested in the ready-mixed form.

17. **Formula K-2-83 - Traffic Signal Yellow Enamel**:

Traffic signal yellow enamel shall meet the provision of Federal Specification TT-E-489 - Enamel, Alkyd, Gloss - and shall match the color of “Standard Interstate Yellow”.

18. **Paint Formulas – Moisture Cured Urethane Paint**

18-A. **General**

The color of the coating system will be specified in the Contract.

Materials shall meet the requirements of those applicable Specifications in SSPC-PA1, “Shop, Field and Maintenance Painting”, which are not in conflict with these Standard Specifications.

The coating system for the “Moisture Cured Urethane” painting process shall coat the steel surfaces with three single component moisture-cured polyurethane coats. The various coats of paint shall be applied in thicknesses as specified in this Section.

Coating Systems which have a maximum recoat window on primer of less than seven Days shall not be used. Coating systems for steel surfaces shall incorporate a primer Capable of being applied at a relative humidity of up to 98 percent, and steel and air temperatures between 35°F and 110°F. The intermediate and top coats shall be full coverage with coating applied to all steel surfaces. All steel coating Materials shall be furnished by the same manufacturer and shall be compatible with one another. The Contractor shall provide a Manufacturer’s Certificate of Compliance for approval at least 5 Working Days before the need arises stating:

a) The coating Materials meet the Materials Specifications.
b) The coating Materials in the coating system are compatible.

c) The manufacturer has manufactured at least one coat of the coating Material in the coating system specified and furnished for the project. Coating Materials for the other coats shall be from the manufacturer's product line and recommended for use in the coating system.

Application of coating Materials shipped to the Project Site will not be permitted until the coating Materials have been approved.

18-B. **Above Ground Application**

Paint supplied for the project shall conform to the following requirements:

(1) Primer (Full Coverage)

Generic Type	Zinc filled, single component, moisture-cured polyurethane
Vehicle Type	Moisture Cured Polyurethane
Pigment Type	Zinc Dust
Pigment content	80% minimum zinc by weight in dry film
Volume Solids	60% plus or minus 2%3% WSDOT
Dry Film thickness	3 mils minimum

All Primer shall be tinted sufficiently with color so as to easily distinguish the dry primer from the blast cleaned steel surface.

(2) Intermediate Coat (Full Coverage)

Generic Type	Micaceous iron oxide filled, single component, moisture-cured polyurethane
Vehicle Type	Moisture Cured Polyurethane
Pigment Type	4.0 lbs/gal micaceous iron oxide
Volume Solids	60% minimum
Finish	Flat (Low Gloss)
Color	Tinted to distinguish from Primer and Top Coat
Dry Film thickness	3 mils minimum

(3) Top Coat (Full Coverage)

Generic Type	Micaceous iron oxide filled, single component, moisture-cured, aliphatic polyurethane
Vehicle Type	Moisture Cured Polyurethane
Pigment Type	Micaceous iron oxide
Volume Solids	60% minimum
Finish	Flat (Low Gloss)
Dry Film thickness	3 mils minimum

The Proportions of the tinting pigments shall be varied to closely match the color of the existing Structure. Three color chip options shall be submitted to the Engineer for a final tinting selection.

Steel coating products furnished for the project shall be manufactured by the same manufacturer and shall be compatible with one another.

18-C. **Below Ground Application**

Paint supplied for the project shall conform to the following requirements:

Surface Preparation: Per SSPC-10

(1) Primer (Full Coverage)

Generic Type:	Zinc filled, single component, moisture-cured polyurethane
Vehicle Type:	Moisture-cured polyurethane
Pigment Type:	Zinc dust
Pigment Content:	80% minimum zinc by weight in dry film
Volume Solids:	60% plus or minus 2%
Dry Film Thickness:	3 mils minimum

All primer shall be tinted sufficiently with color so as to easily distinguish the dry primer from the blast cleaned steel surface.

(2) Top Coat (Full Coverage)

Generic Type:	Single component, moisture-cured, urethane tar with micaceous iron oxide
Color:	Black
Solids by Volume:	61% plus or minus 2%
Flash Point:	> 90°F
Temperature Resistance:	Wet - 180°F continuous, Dry - 240°F continuous
Dry Film Thickness:	4.0 to 6.0 mils

Manufacturing: Steel coating products furnished for the project shall be manufactured by the same manufacturer and shall be compatible with one another.

9-08.2(1) PIGMENTED SEALER MATERIALS FOR COATING OF CONCRETE SURFACES

The pigmented sealer shall be a semi-opaque, colored toner containing only methyl methacrylate-ethyl acrylate copolymer resins, toning pigments suspended in solution at all times by a chemical suspension agent, and solvent. Toning pigments shall be laminar silicates, titanium dioxide, and inorganic oxides only. There shall be no settling or color variation. Tinting shall occur at the factory at the time of manufacture and placement in containers, prior to initial shipment. Use of vegetable or marine oils, paraffin materials, stearates, or organic pigments in any part of coating formulation shall not be permitted. Colors shall be as specified in the Contract. The Contractor shall submit color samples as specified in section 9-08.8.

9-08.3 INSPECTION REQUIREMENTS - GENERAL

The manufacturer shall notify the Engineer of the date on which manufacture is started, and the Engineer shall have the right to inspect all details of the manufacturing process.

Quantities of 20 gallons or less of the above formulas will be accepted without inspection upon the notarized Manufacturer's Certificate of Compliance. This certificate shall contain a statement by the manufacturer to the effect that the Material meets the formula Specification, and shall include a list of materials and quantities used. One copy of the certificate shall accompany the paint when shipped and one copy with a sample of the paint shall be sent to the SPU Materials Laboratory. The paint may be used at once without further release from the SPU Materials Laboratory.

9-08.4 PROCESS OF MANUFACTURE

9-08.4(1) GENERAL

The following process of manufacture shall be used for each paint except aluminum paint. Pigments shall be ground thoroughly in appropriate portions of the specified vehicle to form a paste meeting the requirements set forth in Section 9-08.4(7).

The grinding shall be done in a mill approved by the Engineer. The use of the “colloid” type of mill will not be approved. Weighed quantities of the paste and weighed or measured quantities of the vehicles shall then be mixed thoroughly and strained, if necessary, to form a paint free from skins, lumps, and foreign materials.

9-08.4(2) VISCOSITY ADJUSTMENT

The volatile thinner content of the paint shall be adjusted at the factory to meet the required viscosity, but in no case shall the resultant weight per gallon and nonvolatile content of the paint be below that specified in the formula.

9-08.4(3) WEIGHT VARIATIONS

The weight per gallon of the paint in any lot shall not be less than that stated in the formula. A “lot” as used in this section shall be the quantity of paint ground at one time by any one mill.

9-08.4(4) DRYING TIME AND QUANTITY OF DRIER

The paint shall dry within the length of time stated in each formula but shall not contain sufficient quantities of drier to cause the paint to dry to a nonuniform or nonelastic film. The manufacturer will be permitted to vary the quantity of drier given in the formula sufficiently to accomplish the above results.

9-08.4(5) WORKING PROPERTIES

The paint shall contain no caked material that cannot be broken up readily by stirring. When applied to a clean vertical surface, the paint shall dry without running, streaking, or sagging.

9-08.4(6) STORAGE PROPERTIES

Paints manufactured under these Specifications shall show no skin over the surface after 48 hours in a partially filled container, when tested as outlined in Federal Test Method Standard No. 141. A slight amount of skin or gel formation where the surface of the paint meets the side of the container may be disregarded. Variable percentages of anti-skinning agents are shown in those formulas set forth above that are susceptible to undesirable skin formation. The manufacturer will be allowed to vary the amount of anti-skinning agent given in the formulas provided the above results are accomplished and provided the paint does not dry to a nonuniform or nonelastic film.

9-08.4(7) FINENESS OF GRINDING

The paint shall be ground so that all particles of pigment are dispersed and be coated with vehicle, and the residue on a 325 sieve does not exceed 1 percent by weight of the pigment.

9-08.4(8) RESERVED

9-08.4(9) CONTAINERS

Each container shall be filled with paint and sealed airtight. Each container shall be filled with the amount of paint required to yield the specified quantity when measured at 70°F.

All paint shall be shipped in new suitable containers having a capacity not greater than 5 gallons. Each container shall be marked with a suitable number to identify the particular batch from which it was filled.

9-08.5 TEST METHODS

As set forth in Section 9-08.2, all paints shall meet the special requirements set forth for each formula. The test methods used to check those special requirements shall be as specified by Federal Specification TT-P-141. When test methods are not covered by the above, applicable ASTM methods shall be followed.

9-08.6 SHIPPING

Except for lots of paint in quantities of 20 gallons or less which are accepted upon the Manufacturer's Certificate of Compliance, the manufacturer shall not ship any lot of paint until the paint has been tested and released by the Materials Laboratory. This release will not constitute final acceptance of the paint. Final acceptance will be based on inspection or testing of Project Site samples.

9-08.7 FIELD SAMPLES

Because of the volatility of the solvents used in the paint, the upper limit on viscosity will be waived on all paint samples taken in the field.

9-08.8 COLORS

The Federal Standard color system is a Federal Standard, issued by the General Services Administration. The Federal Standard 595 color system provides means of comparing colors visually. Each Fed-Std-595 color is identified by a five-digit code. For the City of Seattle, the following colors are defined:

Black - 27030

Seattle Safety Yellow – 23594

Seattle Narrows Green - 34227

The Contractor shall submit two minimum 4-inches by 6-inch paint chip samples to the Engineer at least 10-Working Days prior to the scheduled application in accordance with Section 1-05.3. The color of the paint when dry shall match the color of a Standard 595 color chip.

Commission Internationale de l'Eclairage (CIELAB) color system has determined standard values that are used worldwide to measure color. The values used by CIE are called L*, a* and b* and the color measurement method is called CIELAB.

The calculated Delta E shall not exceed 1.0 deviation from the Commission Internationale de l'Eclairage (CIELAB) color measurement analysis method for each color.

For the City of Seattle, the following colors are defined:

COLOR	Ill/OBS	L*	a*	b*
Washington Gray	D65/10-degrees	62.59	0.98	5.23
	A/10-degrees	63.06	1.80	5.70
	CWF/10-degrees	63.02	0.73	6.08
Cascade Green	D65/10-degrees	36.62	-6.53	-0.89
	A/10-degrees	35.82	-7.15	-2.53
	CWF/10-degrees	36.34	-5.09	-1.18
Mt. Baker Gray	D65/10-degrees	45.94	1.38	4.46
	A/10-degrees	46.40	1.70	5.05
	CWF/10-degrees	46.46	1.07	5.48
Mt. St. Helens Gray	D65/10-degrees	56.07	2.15	6.68
	A/10-degrees	56.76	3.08	7.52
	CWF/10-degrees	56.67	1.64	7.85
Seattle Railroad Green	D65/10-degrees	27.32	-0.97	0.01
	A/10-degrees	27.22	-1.14	-0.22
	CWF/10-degrees	27.35	-0.73	0.14

For the respective colors shall conform to the above CIELAB analysis.

The Contractor shall submit the specified and spectrophotometer or colorimeter readings taken in accordance with ASTM D 2244 to the Engineer at least 10-Working Days prior to the scheduled application in accordance with Section 1-05.3. The Contractor shall not begin applying until receiving the Engineer's written approval of the color samples.

One-quart wet samples (Engineer's Option)

When requested by the Engineer, the Contractor shall submit a one-quart wet sample companion drawdown color sample and for each batch of material

The 1-quart wet sample shall be submitted in the manufacturer's labeled container with product number, batch number, and size of batch. The companion drawdown color sample shall be labeled with the product number, batch number, and size of batch. The Contractor shall submit the specified samples to the Engineer at least 10-Working Days prior to the scheduled application or upon request by the Engineer with in accordance Section 1-05.3. The Contractor shall not begin applying until receiving the Engineer's written approval of the samples.

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SECTION 9-09 TIMBER AND LUMBER

9-09.1 GENERAL REQUIREMENTS

All timber and lumber for Structures shall be Douglas Fir-Larch, unless specified otherwise in the Contract. The allowable species of timber and lumber for guardrail posts shall be Douglas Fir-Larch or Hem Fir. Timber and lumber for sign posts, mileposts, sawed fence posts, and mailbox posts, shall be Western Red Cedar, Douglas Fir-Larch, or Hem Fir.

9-09.2 GRADE REQUIREMENTS

Timber and lumber shall conform to the grades and usage as follows. Grades shall be determined by the current standards of the West Coast Lumber Inspection Bureau (WCLIB) or the Western Wood Products Association (WWPA).

Structures

Timber and lumber, unless specified otherwise in the Contract, shall conform to the following:

Materials 2" to 4" nominal thick, 5" nominal and wider (Structural Joists and Planks)	No. 1 and better, grade (Section 123-b of WCLIB) or (Section 62.11 of WWPA)
Materials 5" nominal and thicker (Beams and Stringers)	No. 1 and better, grade (Section 130-b of WCLIB) or (Section 70.11 of WWPA)

Timber lagging for soldier pile walls shall be Douglas Fir-Larch, grade No. 2 or better.

Guardrail Posts

Timber and lumber for guardrail posts (classified as Posts and Timbers) shall conform to the grades as follows.

Douglas Fir	No. 1 and better, grade (Section 131-b WCLIB) or (Section 80.11 WWPA)
Hem Fir	Select Structural, grade (Section 131-a WCLIB) or (Section 80.10 WWPA)

Mileposts, Sawed Fence Posts, and Mailbox Posts

Mileposts, sawed fence posts, and mailbox posts shall conform to the grades listed in the following table:

4x4	Construction grade (Light Framing, Section 122-b WCLIB) or (Section 40.11 WWPA)
4x6	No. 1 and better, grade (Structural Joists and Planks, Section 123-b WCLIB) or (Section 62.11 WWPA)
6x6, 6x8, 8x10	No. 1 and better, grade (Posts and Timbers, Section 131-b WCLIB) or (Section 80.11 WWPA)
6x10, 6x12	No. 1 and better, grade (Beams and Stringers, Section 130b WCLIB) or (Section 70.11WWPA)

Sign and parking meter posts shall meet the Material requirements specified in Section 9-28.2.

9-09.2(1) SURFACING AND SEASONING

All timber and lumber shall be sized as indicated on the Drawings.

All timber and lumber to be painted shall be surfaced on all sides. All timber and lumber to be painted shall be thoroughly air or kiln dried to an equilibrium moisture content and shall be stored in such a manner as to remain in a thoroughly dry condition until placed into the Work.

9-09.2(2) RESERVED

9-09.2(3) INSPECTION

Timber and lumber shall be marked with a certified lumber grade stamp provided by one of the following agencies:

West Coast Lumber Inspection Bureau (WCLIB)
Western Wood Products Association (WWPA)
Pacific Lumber Inspection Bureau (PLIB)
Any lumber grading bureau certified by the American Lumber Standards Committee

A grading certificate shall accompany each order of timber and lumber for use in Structures as specified in Section 9-09.2. In consideration of being acceptable, the certificate shall be issued by either the grading bureau whose stamp is shown on the material, or by the lumber mill which is under the supervision of one of the grading bureaus listed above. The grading certificate shall include the following:

1. Name of the mill performing the grading,
2. The grading rules being used,
3. Name of the person doing the grading with current certification,
4. Signature of a responsible mill official,
5. Date the lumber was graded at the mill, and
6. Grade, dimensions, and quantity of the timber or lumber.

When the Material is delivered to the project, the Engineer will check the order for the appropriate grade stamp. The invoice and grading certificate accompanying the order shall be accurate and complete with the information listed above. The grading certificate and grade markings will not constitute final acceptance of the Material. The Engineer may reject any or all of the timber or lumber that does not comply with the Specifications or has been damaged during shipping or upon delivery.

9-09.3 PRESERVATIVE TREATMENT

All timber and lumber requiring preservative treatment shall be treated in accordance with AASHTO M 133. As specified by AASHTO M 133, the American Wood-Preservers' Association (AWPA) standards shall govern the Specifications. These Specifications include: storing and curing the timber and lumber, the wood preservatives, the preservative treatment process, documenting the results of the treatment, inspection, testing, and the identification of properly treated timber. Unless otherwise specified in the Contract, all timber and lumber shall be treated in accordance with Sections U1 and T1 of the latest edition of the AWPA standards.

All cutting, boring, chamfering, routing, surfacing, and trimming shall be done prior to treating. Any field drilling or cutoffs shall be treated by two liberal applications of a compatible preservative. The applications shall be in accordance with the requirements of AWPA Standard M-4 entitled, "Standard for the Care of Pressured Treated Wood Products".

All charges shall consist of pieces of the same species that are similar in form, size, moisture content, and receptivity to treatment. The pieces in the charge shall be separated to ensure contact of treating medium with all surfaces. The method of determining the retention of the preservatives shall be by assay.

As specified in the Contract, all orders of treated timber and lumber will be accompanied by a Certificate of Treatment record.

The Certificate of Treatment shall include the following information:

- Name and location of the wood preserving company
- Customer identification
- Date of treatment and charge number
- Type of chemical used and amount of retention
- Treating process and identification of the Specification used
- Description of material that was treated
- Signature of a responsible plant official

In addition to the Certificate of Treatment, all orders of treated timber or lumber shall be accompanied by a Grading Certificate in accordance with Section 9-09.2(3). Such certification or approved for shipment tag shall not constitute final acceptance of the material. The Engineer may reject any or all of the timber or lumber that does not comply with the Specifications or has been damaged during prolonged storage, shipping, or upon delivery.

All timber and lumber to be used in aquatic environments, unless specified otherwise in the Contract, shall be chemically treated using Best Management Practices (BMPs). The producer of the chemically treated products shall supply a written certification that the BMPs were utilized, including a description and appropriate documentation of the BMPs used. This information may be included on the Certificate of Treatment record.

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SECTION 9-10 PILES

9-10.1 TIMBER PILES

9-10.1(1) GENERAL

Timber piles shall be untreated or treated with the preservatives specified on the Drawings and completely described in Section 9-09.3.

Timber piles shall have the following limiting diameters:

LENGTH IN FEET	MIN. BUTT DIA. 3 FT. ABOVE BUTT (INCH)	MAX. BUTT DIA. 3 FT. ABOVE BUTT (INCH)	MIN. TIP DIA. (INCH)
Under 40	12	20	7
40 – 54	12	20	7
55 – 74	13	20	7
Over 74	14	20	7

Timber piles shall be strapped with at least three straps: one approximately 18 inches from the butt, one approximately 24 inches from the butt, and one approximately 12 inches from the tip. Additional straps shall be provided at approximately 15-foot centers between the butt and tip. Strapping shall encircle the pile once and be tensioned as tightly as possible. Straps shall be 1-1/4 inches wide, 0.031 inch thick, cold rolled, fully heat treated, high tensile strapping, painted, and waxed, with an ultimate tensile strength of 5,100 pounds. The seal shall be 2-1/4 inches long, 20 gage, crimped with a notch type sealer to furnish a joint yielding 80 percent of the strap tensile strength. Treated timber piles shall be strapped after treatment.

9-10.1(2) UNTREATED PILES

Except where specifically provided otherwise, untreated timber piles shall be Douglas fir, Western red cedar, or larch. Piles for foundations shall be Douglas fir. Piles shall be cut from sound, live trees and shall contain no unsound knots. Sound knots will be permitted, provided the diameter of the knot does not exceed 4 inches, or 1/3 of the small diameter of the pile at the point where they occur, whichever is smaller. Any defect or combination of defects that impair the strength of the pile more than the maximum allowable knot will not be permitted.

Piles shall be cut above the butt swell and shall have a uniform taper from butt to tip. A line drawn from the center of the tip to the center of the butt shall not fall outside the center of the pile at any point more than 1 percent of the length of the pile. A spiral grain or twist in excess of 1/4 turn in 10 feet of length will be cause for rejection.

Untreated timber trestle piles shall have an average of at least five annual rings per inch measured radially over a distance of 3 inches at the butt, beginning at a point 3-1/2 inches from the heart. At least 9 inches of heartwood shall show at the butt.

Ring count requirements for untreated timber foundation piles and detour trestle piles will be waived.

9-10.1(3) CREOSOTE TREATED PILES

For creosote treated piles, Douglas fir timber shall be used. All other requirements shall be the same as for untreated piles except that the ring count requirement will be waived.

9-10.1(4) TIMBER COMPOSITE PILES

Timber composite piles shall consists of a pile made up of two timber sections. The lower section shall be untreated, and the upper section shall be creosote treated.

The treated and untreated sections of timber composite pile shall meet the respective requirements specified above for full length of treated and untreated timber piles.

9-10.1(5) PEELING

Untreated and creosote treated piles shall be peeled by removing all of the rough bark and at least 80 percent of the inner bark. No strip of inner bark remaining on the pile shall be over 3/4 inch wide or over 8 inches long, and there shall be at least 1 inch of clean wood surface between any two such strips. Not less than 80 percent of the surface on any circumference shall be clean wood. All knots shall be trimmed close to the body of the pile.

9-10.2 CONCRETE PILES

9-10.2(1) CONCRETE

Portland cement meeting the requirements of Section 9-01 shall be used in all precast concrete piles.

The concrete for precast-prestressed piles shall conform to the requirements of Section 9-19. The concrete for prestressed piles shall have a minimum compressive strength of 6,000 psi at the age of 28 Days. The minimum compressive strength of concrete at the transfer of prestress shall be 3,300 psi.

The concrete for all other precast piles shall be Class 4000P. Mixing, transporting, and placing concrete shall be in accordance with the provisions of Section 6-02.3.

The Contractor shall mold and test a sufficient number of concrete test cylinders to determine the strength of the concrete as required by the Specifications. Under the surveillance of the Engineer, the test cylinders shall be molded, cured, and tested in accordance with the procedures established by the Laboratory.

In the event that a sufficient number of concrete test cylinders are not molded to satisfy all testing required on any one pile, cores measuring 4 inches in diameter by 5 inches in height shall be taken and tested by the Contractor. If the strength of the core meets the required compressive strength of the concrete, the pile may be accepted. The coring and testing of the core shall be done under the surveillance of the Engineer.

9-10.2(2) REINFORCEMENT

Reinforcement shall meet the requirements of Section 9-07.

9-10.3 CAST-IN-PLACE CONCRETE PILES

9-10.3(1) REINFORCEMENT

Reinforcement for cast-in-place concrete piles shall conform to the requirements of AASHTO M 31, Grade 60.

9-10.4 STEEL PILE TIPS AND SHOES

Steel pile tips and shoes shall be fabricated of cast steel conforming to ASTM A 148, Grade 60-90 [620-415] or ASTM A 27, Grade 65-35 [450-240] and be free from any obvious defects. Pile tips shall be accompanied by a mill test report stating the chemical and physical properties (tensile and yield) of the steel.

9-10.5 STEEL PILES

The Material for steel piles and pile splices shall conform to ASTM A 36, except the Material for steel pipe piles, and splices shall conform to the requirements of ASTM A 252, Grade 2. All steel piles may be accepted by the Engineer based on the Manufacturer's Certificate of Compliance.

SECTION 9-11 WATERPROOFING

9-11.1 ASPHALT FOR WATERPROOFING

Asphalt for waterproofing shall conform to the requirements of ASTM D 312, Type 4.

The Material used as primer shall conform to the requirements of ASTM D 41, "Primer for Use with Asphalt in Dampproofing and Waterproofing".

Acceptance shall be as provided in Section 9-02.2(1).

9-11.2 WATERPROOFING FABRIC

Waterproofing fabric shall be a saturated cotton fabric meeting the requirements of ASTM D 173, "Woven Cotton Fabrics Saturated with Bituminous Substances for Use in Waterproofing".

9-11.3 PORTLAND CEMENT MORTAR

Portland cement and fine sand for the mortar protection course shall conform to the following requirements:

Portland Cement	Section 9-01
Sand	Section 9 03.1(2)C
Mortar	Section 9-20.4

SECTION 9-12 MAINTENANCE HOLES, CATCH BASINS, AND INLETS

9-12.1 REINFORCED CONCRETE

9-12.1(1) GENERAL

Reinforced concrete shall consist of Portland cement, fine and coarse aggregates and water, in which steel has been embedded in such manner that the steel and concrete act together.

All cast-in-place concrete placed under these Standard Specifications shall be Class 4000 (see Sections 6-02.3(1) and 6-02.3(2)). Strength determination shall be in accordance with ASTM C 39. Precast components shall conform to the strength requirements of ASTM C 478.

The use of admixtures shall require prior approval of the Engineer. Concrete with air-entraining admixture shall comply with ASTM C 175.

9-12.1(2) CEMENT

Portland cement shall conform to the requirements of Section 9-01.

9-12.1(3) STEEL REINFORCEMENT

Reinforcement shall consist of wire conforming to ASTM A 82 or ASTM A 496, or wire fabric conforming to ASTM A 185 or ASTM A 497, or Grade 60 steel bars conforming to ASTM A 615 or Grade 80 steel bars conforming to ASTM A 306.

9-12.1(4) AGGREGATES

Aggregates for cast-in-place concrete shall conform to ASTM C 33.

9-12.2 STEPS, HANDHOLDS, AND LADDERS

9-12.2(1) GENERAL

The Material for maintenance hole steps, ladders, and handholds shall be the same material in any individual drainage Structure. See Section 7-05.3(1)Q for submittal requirement. Sizes of components, dimensions and layout shall conform to Standard Plan no. 232.

9-12.2(2) POLYPROPYLENE ENCAPSULATED REINFORCING STEEL

Polypropylene steel reinforced steps shall be made of copolymer polypropylene plastic that encapsulates a 1/2 inch diameter grade 60 steel reinforcing steel. Steel reinforcing shall conform to the requirements of ASTM A 615, and copolymer

polypropylene plastic shall conform to requirements of ASTM D 4101. Steps shall have serrated tread, measure 13 inches center to center between legs of the step, and be designed to withstand pullout forces of 1500 pounds.

The Contractor may, with the Engineer's approval, use "Plastic Maintenance Hole Steps" manufactured by Lane International Corporation, or "Steps" manufactured by M.A. Industries, Inc.

9-12.3 RESERVED

9-12.4 MORTAR AND GROUT FOR SEWER AND DRAINAGE STRUCTURES

9-12.4(1) MORTAR FOR JOINTS

Mortar for jointing precast or masonry maintenance hole, catch basin, or inlet units shall be one part Portland cement to not less than one part nor more than two parts plaster sand, mixed with the least amount of clean water necessary to provide a workable mortar. Joints between precast maintenance hole elements shall also be rubber gasketed as noted in Section 7-05.3(1)K.

9-12.4(2) MORTAR FOR PLASTER-COATING

Mortar for plaster-coating or lining masonry unit maintenance holes shall be proportioned according to either of the two alternates tabulated as follows:

ALTERNATE	PARTS BY VOLUME PORTLAND CEMENT	PARTS BY VOLUME MASONRY CEMENT	VOLUME HYDRATED LIME OR LIME PUTTY	PLASTER SAND MEASURED IN DAMP LOOSE CONDITION
1	1	1 (Type II)	0	Not less than 2-1/4 and not more than 3 times the sum of volumes of cement and lime
2	1	0	¼	

9-12.4(3) GROUT

Grout for filling the void in Sewer and Drainage Structures where pipe connections are made shall be non-shrink cement sand grout complying with the requirements of Section 9-04.3(2).

9-12.5 CONCRETE MASONRY UNITS

Concrete masonry unit (also called concrete masonry block) shall conform to ASTM C 139, "Specification for Concrete Masonry Units for Construction of Catch Basins and Maintenance Holes", except that nominal horizontal thickness shall be 6 inches measured radially, and blocks shall have semicircular mortar grooves approximately 1 inch radius at the ends.

9-12.6 CONCRETE BRICK

Concrete brick shall conform to the Specifications for Concrete Building Brick ASTM C 55, Grade S.

9-12.7 CLAY BRICK

Clay brick shall conform to ASTM C 32, Grade MM unless otherwise specified in the Contract.

9-12.8 METAL CASTINGS

9-12.8(1) MAINTENANCE HOLE RING AND COVER

Ring and cover casting dimensions shall conform to the Standard . Rings and ring extensions shall be manufactured from gray iron ASTM A 48, Class 30 or ductile iron ASTM A 536, Grade 80-55-06. Covers shall be manufactured from ductile iron ASTM A 536, Grade 80-55-06. Rings and covers shall be free of defects such as porosity, pittings, shrink cavities, cold shuts, cracks, and other surface defects which would impair serviceability. Repair of defects by welding or by the use of "smooth-on plasticized metals" or similar Material will not be accepted. Manufacturer shall certify that the product conforms to the requirements of these Specifications. In accordance with Section 1-06.1, where source of Material is different from manufacturer, the Contractor shall also provide the name and location of the manufacturer

Castings shall be bare metal. Artificially coated or painted castings will be cause for rejection.

Castings shall be machine finished on the horizontal seating surface and the vertical facing surface common to the ring and cover, so as to assure full bearing (nonrocking) for the entire width and circumference of the bearing surface, and permit interchangeability with other castings of the same design, no matter what the source. The vertical face common to the ring and cover shall be beveled as shown on the Standard . Upon request of the Engineer, the manufacturer shall furnish at the foundry standard ring and covers for use by Inspectors in testing fit and seating.

All covers shall be labeled with the following information:

1. Name or symbol of the manufacturer;
2. Owner's name (City of Seattle, min. 1/2 inch letters recessed flush with adjacent surface);
3. Material label "DUC" for Ductile Iron;
4. Identification of its use in 3 inch high lettering (Sewer, Drain, etc.); and
5. Country of manufacture/origin.

Items 2. and 4. shall be on the exposed face of the cover. Items 1., 3., and 5. shall be located at the manufacturer's option. If located on the exposed face of the cover, item 1. and 3. shall be adjacent to each other and shall be set in at least 1/2 inch high recessed letters. Where lock-type castings are called for, a locking device shall permit the cover to be readily

released from the ring. Movable parts shall be made of non-corrosive metals and be designed to avoid possible binding. Upon request by the Engineer, the manufacturer shall furnish testing apparatus at the foundry Capable of applying uplift pressure on the lid of at least 20 foot head of water which the assembly needs to withstand without failure.

All maintenance hole rings shall be labeled with the name or symbol of the manufacturer and the type of Material.

9-12.8(2) METAL FRAME AND GRATE AND METAL COVER FOR CATCH BASINS OR INLETS

The frame may be made of gray iron, ASTM A 48, Class 30, or ductile iron, ASTM A 536, Grade 80-55-06, at the manufacturer's option. The grate and cover shall be made of ductile iron only. Other applicable provisions of Section 9-12.8(1) shall apply, except item (4) for identification marking.

Catch Basins, Type 242A and 242B and Inlets, Type 250A and 250B shall be furnished with a vaned grate as indicated on Standard Plan nos. 265 and 266.

9-12.8(3) CAST METAL INLETS

The castings for cast metal inlets shall be cast steel or ductile iron as specified in Section 9-06.8 or Section 9-06.14. Substitutions may be accepted (see Section 1-06.1). Vaned grates shall be embossed as indicated on Standard Plan no. 264.

9-12.9 JUNCTION BOX

Junction box shall comply with Standard Plan no. 277 and reinforcing shall be per WSDOT Standard Plan for Type 1 catch basin.

9-12.10 SHOP FABRICATED CORRUGATED METAL MAINTENANCE HOLES

Where corrugated metal maintenance holes are specified, they shall conform to the details as indicated in the Contract. All pipe connections to the maintenance hole stubs shall be made with a standard band type as shown on the Drawings.

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

9-12.11 MONOLITHIC CONCRETE MAINTENANCE HOLES

Monolithic concrete maintenance holes shall conform to the Standard .

9-12.12 OUTLET TRAPS

Catch Basin outlet traps shall be constructed in accordance with Standard Plan no. 267a.

9-12.13 GRATE INLETS AND DROP INLETS

Steel in grates, angles, and anchors for grate inlets and drop inlets shall conform with AASHTO M 183, except structural tube shall conform with ASTM A 500, Grade B. After fabrication, the steel shall be hot-dip galvanized with a minimum coating of 2 ounces of zinc per square foot in accordance with AASHTO M 111 or galvanized with a hot-sprayed (plasma flame applied) 6 mil minimum thickness zinc coating.

Steel grating shall be fabricated by weld connections. Bearing bars and cross bars shall be resistance welded at the intersecting joints. Welds, welding procedures, and welding Materials shall conform to Standard Specifications for Welding issued by the American Welding Society.

Vaned grates shall be embossed as indicated on Standard Plan no. 264.

Substitution of grate designs will be permitted with the approval of the Engineer if:

1 - the hydraulic capacity is not decreased,
2 - the overall dimensions are the same allowing the grate to be interchangeable,
3 - the strength is at least equal to the grate shown in the Standard , and
4 - a Manufacturer's Certificate of Compliance is submitted indicating compliance with items 1, 2, and 3.

The Contractor has the option of furnishing either cast-in-place or precast inlets unless otherwise shown in the Contract. Alternate designs are acceptable provided they conform to fabricator's Shop Drawings approved by the Engineer for projects prior to Award of Contract.

SECTION 9-13 RIPRAP, QUARRY SPALLS, AND SLOPE PROTECTION

9-13.1 GENERAL

The stone for riprap and quarry spalls shall be hard, sound and durable. It shall be free from segregation, seams, cracks, and other defects tending to destroy its resistance to weather. Riprap and quarry spalls used for new rock facing or slope stabilization shall meet requirements in Section 9-03.17.

9-13.2 LOOSE RIPRAP

Loose riprap shall be free of rock fines, soil, or other extraneous material.

Should the riprap contain insufficient 4" to 8" spalls, as defined in Section 9-13.7, the Contractor shall furnish and place supplementary spall material from a source approved by the Engineer, at the Contractor's sole expense.

The grading of the riprap will be determined by the Engineer by visual inspection of the load before it is dumped into place, or, if so ordered by the Engineer, by dumping individual loads on a flat surface and sorting and measuring the individual rocks contained in the load.

9-13.2(1) HEAVY LOOSE RIPRAP

Heavy loose riprap shall meet the following requirements for grading:

	MINIMUM SIZE	MAXIMUM SIZE
40% to 90%	1 ton (1/2 cubic yd.)	
70% to 90%	300 lbs. (2 cu. ft.)	
10% to 30%	3 inch	50 lbs. (spalls)

9-13.2(2) LIGHT LOOSE RIPRAP

Light loose riprap shall meet the following requirements for grading:

	SIZE RANGE	MAXIMUM SIZE
20% to 90%	300 lbs. to 1 ton (2 cu. ft. to ½ cu. yd.)	
15% to 80%	50 lbs. to 1 ton (1/3 cu. ft. to ½ cu. Yd.)	
10% to 20%	3 inch	50 lbs. (spalls)

9-13.3 HAND PLACED RIPRAP

Hand placed riprap shall be as nearly rectangular as possible, 60 percent shall have a volume of not less than 1 cubic foot. No stone shall be used which is less than 6 inches thick, nor which does not extend through the wall.

9-13.4 SACK RIPRAP

Sack riprap shall consist of concrete placed in sacks made of at least 10 ounce burlap and having a capacity of approximately 2.5 cubic feet. Each sack shall be filled with approximately 1 cubic foot of concrete having a consistency in conformance with Section 6-02.3(3)D for non-vibrated concrete.

For sack riprap exposed to fresh water, the concrete shall be unreinforced Class 2300; and for sack riprap exposed to salt water, the concrete shall be Class 3000 as specified in Section 6-02.3.

The Portland cement and fine and coarse aggregates shall conform to the requirements for Portland cement and fine and coarse aggregate of Sections 9-01 and 9-03.1, respectively.

9-13.5 RESERVED

9-13.6 CONCRETE SLOPE PROTECTION

9-13.6(1) GENERAL

Concrete slope protection shall consist of reinforced Portland cement concrete poured or pneumatically placed upon the slope with a rustication joint pattern or semi-open concrete masonry units placed upon the slope closely adjoining each other.

9-13.6(2) SEMI-OPEN CONCRETE MASONRY UNITS SLOPE PROTECTION

Precast cement concrete blocks shall conform to the requirements of ASTM C 90, Type II.

9-13.6(3) POURED PORTLAND CEMENT CONCRETE SLOPE PROTECTION

Cement concrete for concrete slope protection shall be Class 3000 in conformance with Section 6-02.3.

Wire mesh reinforcement shall conform to Section 9-07.7.

9-13.6(4) PNEUMATICALLY PLACED PORTLAND CEMENT CONCRETE SLOPE PROTECTION

Cement: This Material shall be Portland cement as specified in Section 9-01.

Aggregate: This Material shall meet the requirements for fine aggregate as specified in Section 9-03.1. The moisture content of the fine aggregate at the time of use shall be between 3 percent and 6 percent by weight.

Reinforcement: Wire mesh reinforcement shall conform to the provisions of Section 9-07.7.

Water: Water shall conform to the provisions of Section 9-25.1.

9-13.7 QUARRY SPALLS

The spall shall be hard, sound, and durable. It shall be free from fracture, seams, cracks, and other discontinuities tending to adversely impact its resistance to weathering. The quarry spall shall meet the 5 test requirements listed in Section 9-03.17. Quarry spalls shall meet the following gradation requirements:

2 INCH TO 4 INCH QUARRY SPALL

SIEVE SIZE	PERCENT PASSING
4 inch	100
2 inch	40 max.
1-1/4 inch	5 max.

4 INCH TO 8 INCH QUARRY SPALL

SIEVE SIZE	PERCENT PASSING
8 inch	100
4 inch	40 max.
2 inch	5 max.

All percentages are by weight.